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**Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.**

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## Beaded or Pearl Lightning Flashes.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

THE employment of the camera in the study of various natural phenomena has led one to put less faith in many visually recorded appearances until they can be recorded on the photographic plate. Assuming that the objects are bright enough to indicate a photographic record and that their occurrence is common enough to fall within the field of some of the innumerable cameras that are in use to-day, it is quite legitimate to place some doubt on their existence until the unerring plate presents us with, at any rate, one lasting image, or failing this, some satisfactory explanation is given to show why such a record cannot be secured.

The particular object to which attention is drawn here is the so-called "beaded," "pearl," or "chapletted" form of lightning flash, which observers, during thunderstorms, have minutely described and written about. The ordinary lightning flash, as our readers are aware, is a continuous bright streak in the air, wavy in form, and very river-like in appearance, owing to the many branches or ramifications which spring out from the main stream. Several instances of such flashes are illustrated in Fig. 1, which is from an excellent photograph taken by Mr. T. N. Leslie at Vereeniging and recently sent to the writer.

**Fig. 1.—A series of Lightning Flashes proceeding from a Cloud to the Earth, illustrating the river-like form of the Discharges and the Continuity of the Streaks representing the several Flashes.**
*(Photographed by T. N. Leslie at Vereeniging, Transvaal.)*

The "beaded" form, on the other hand, is generally described as a single streak, wavy in form, devoid of all branches, but broken up along its whole length into a series of consecutive bright points, dots, or beads. This appearance has sometimes been termed "chain" lightning in addition to the other names already mentioned.

In order to give the reader some idea of the numerous visual observations which have been described from time to time, reference will first be made to a few accounts which have been gleaned from various publications.

During a storm which passed over Paris on August 18, 6 a.m., in 1876, Monsieur G. Planté observed a remarkable flash, which he described as follows (*Comptes Rendus*, vol. lxxxiii., p. 484, 1876) :—

"But the most remarkable of them all was the flash which went from cloud to earth, describing a kind of elongated S, and which remained visible for an appreciable moment, forming a chaplet of brilliant particles. . . ."

Monsieur Planté here suggests the name *éclairs en chapelet*, and points out that flashes of this type should be classified together.

In this note also he refers to an account given of several flashes which occurred in London during a storm on June 19, 1857. The Comte du Moncel (Notice sur le tonnerre el les éclairs, p. 54), describing the observations, remarked that several flashes "persisted for several moments, and only disappeared after being broken up into points of light (en lumière granulaire)."

In *Nature* (vol. xviii., p. 260, 1878) a description is there given of what is called a remarkable flash of lightning which was observed by Mr. B. St. J. B. Joule at Southport on August 16, 1877. It reads as follows :—

"I was standing at the shore end of Leicester Street watching the approach of the storm, and observing the progress and duration of the more important flashes, when about 8 o'clock a vivid flash of lightning fell apparently into the channel (the water being not much above low water mark of a neap tide) about one-sixth of a mile north of the end of the pier. In about a minute afterwards another fell about one-sixth of a mile north-east of the previous one, and after a similar interval a third stream of electricity descended about another one-sixth of a mile in the same direction. The first and third flashes were of the usual character of forked lightning, but the second presented an appearance which I do not recollect to have witnessed before. From its exit from the clouds to its fall into the sea it seemed composed of small detached fragments which caused it to assume the aspect depicted below."

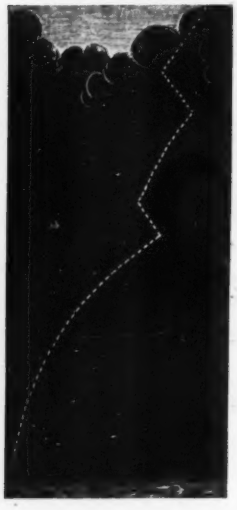

Fig. 2.—Mr. Joule's Drawing of "Beaded" Lightning as observed by him. (*From "Nature."*)

According to Mr. Joule, the same flash was seen by Mr. Thistlethwaite, and it appeared to him "exactly as I have depicted it."

Fig. 2 represents the flash as drawn by him, and is reproduced from a woodcut that accompanied his communication to *Nature*, by permission of the editor of that journal.

Mr. E. J. Lawrence, referring in the same journal (vol. xviii., p. 278, 1878) to the flash of lightning seen by Mr. Joule, wrote :—

"Some forty years ago, in a thunderstorm which I had the good fortune to witness at Ampton, in Suffolk, the lightning (with heavy rain) was almost incessant for half-an-hour or more, and about a quarter of the flashes (speaking from memory only) presented this unusual appearance. I have often looked out for it since, but only once with success, and then it only showed itself in a single flash out of many. On both occasions the "punctuated" flashes presented in general a curved or sinuous line without sharp angles."

The observation made by Mr. Joule seemed to be more common than was at first anticipated, and his account of it brought forward many descriptions of previous occurrences. Thus, Mr. Wood Smith, writing from Hampstead Heath on July 12, 1878, said (*Nature*, vol. xviii., p. 302, 1878) :—

"During a thunderstorm on August 24, 1873, I saw a flash of lightning exactly answering to Mr. Joule's description of 'punctuation.' The note of the storm in my diary says :—'Lightning and thunder very frequent. *One flash, very near, had the appearance of a chain of alternate links*, and remained visible, I should think, for half a second, gradually fading out.' This persistence

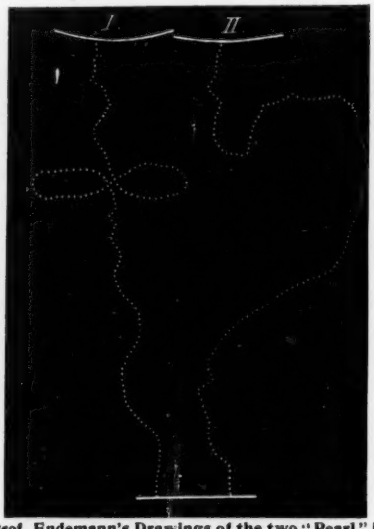


Fig. 3.—Prof. Endemann's Drawings of the two "Pearl" Lightning Flashes, as observed by him. (*From "Met. Zeit."*)

was, no doubt, mainly an optical illusion, but it shows the definiteness of the form. The flash was from cloud to cloud, and followed a very sinuous line, as described by Mr. Lawrence. Is not this what old books describe as chain lightning?"

In more recent years similar kinds of flashes have been recorded.

Professor Endemann described two flashes which he observed in a storm which occurred at Celle (Province Hannover) on July 5, 1888 (*Meteorologische Zeitschrift*, vol. v., p. 483, 1888) in the following words :—

"On this occasion I observed two flashes of a peculiar form as shown in the accompanying figure. . . I may remark, finally, that both flashes did not show a continuous bright line, but were composed of single, closely-placed points of light in the form of a string of pearls."

By the courtesy of the editors of the *Meteorologische Zeitschrift* I am permitted to reproduce these drawings, and they are shown in Fig. 3.

We have also an account of an observation made by Professor Fr. Jäger, who also observed a curious flash, which was described (*Metcorologische Zeitschrift*, vol. ix., p. 359, 1892) as follows :—

"Another curious appearance is a looped-form (Schleifen-förmig) of lightning which Professor Jäger observed on July 27, 1892; the loop showed quite distinctly a picture like a string of pearls."

Dr. L. Hapke, of Bremen, has also recorded a "beaded" flash of lightning. Writing to the *Meteorologische Zeitschrift* (vol. x., p. 227, 1893) he said:—

"I observed a curious form of zig-zag lightning on September 5, 1880, 6.30 p.m., in front of the harbour houses at Vegesack as a storm from Stedingerlande approached from the south-west direction. The distance of the flashes was three to four kilometres. From a long, drawn-out flash, which at first was of a sharp zig-zag form, a rocket-like scintillation appeared to go out, whereby the flash, which lasted somewhat longer than the other, resolved itself into small, single, red balls, which appeared like a meteor with a short tail and then disappeared."

In the same communication he refers also to an observation made by the physicist, Muncke, who saw a flash strike downwards and dissolve into a great number of small brilliant balls.

Another interesting observation is one which we owe to Kapuscha. Writing from Vienna (*Meteorologische Zeitschrift*, vol. xiii., p. 279, 1896) he said the second flash he saw was "quite vertical, and had an extension of about 15° to 20°; it shone with the usual colour of lightning, and was furnished with about 10-12 yellow shining points, which, while the flash in question had already disappeared, was still visible half a second longer. . . . The whole discharge gave the impression of a string of pearls sparsely distributed. . ."

Professor Riggenbach-Burckhardt relates (*Meteorologische Zeitschrift*, vol. xiv., p. 62, 1897) that Fechter, during a storm which passed over Schwanden, Canton Glarus, in September, 1894, observed five or six flashes following one another in the same track. These came from a not very dense rain cloud to earth, and appeared to be all broken up into small, regular pieces.

The last observation which will here be referred to is that made by Dr. F. Pockels (*Meteorologische Zeitschrift*, vol. x., p. 73, 1893) in the neighbourhood of Göttingen, in North Germany.

"On the evening of October 1, 1892," he wrote, "after an exceptionally warm day, a storm came up from the north-east, which I observed in an open field near Bovenden Station, six kilometres from Göttingen to the north.

"The proportionately large number of flashes of the slow, withdrawing storm were, for the main part, long, drawn-out discharges within the clouds; those which ran to earth gave me the impression that their path for an appreciable time (I gauged it at most one second) glowed with a ruddy light decreasing in intensity (like the carbons of an electric lamp when the current is suddenly switched off). About 8 o'clock . . . I observed in one direction two flashes striking the earth at a moderate distance (which still was about five kilometres away).

"By these two flashes I noticed with the greatest astonishment that the afterglow of the lightning path was not continuous along its path, but consisted of a series of distinct separate points separated from each other by equal intervals, so that the appearance, in fact, was just comparable with a shining string of pearls. Both these flashes had their starting points, perhaps about 15° to 20° altitude; their paths were undoubtedly curved. The number of shining points was rather large, perhaps about 30 to 40 on the whole path. . ."

With so many clearly described observations of this form of lightning, it seems at first sight that one cannot do otherwise than accept it as a type of lightning flash which sometimes takes place.

We appear to have, however, here an instance, as I have previously mentioned, where the camera may be called in to give evidence, for the case is one which should, if possible, be verified by photography. Such flashes ought to appear "beaded" on the sensitive film. It will be shown in a subsequent part of this article, however, that the photographing of a "beaded" flash is one of very great difficulty.

The reader must be reminded that even if plates exposed during thunderstorms at night do exhibit markings on them which have the appearance of this "beaded" form of trail, care must be taken that they are not the result of photographing bright objects other than lightning itself!

**Fig. 4.—Photograph of supposed "Beaded" Lightning, taken by Van der Valk at Davos, on July 15, 1896.** (*From "Met. Zeit."*)

**Fig. 5.—Photograph of supposed "Beaded" Lightning, taken by Van der Valk on December 9, 1895.** (*From "Met. Zeit."*)

The only instances with which I am acquainted when photographs of a "beaded" flash have been recorded as having been obtained are those which Professor Riggenbach-Burckhardt describes in a communication to the *Meteorologische Zeitschrift* (vol. xiv., p. 62, 1897). In this Professor Burckhardt gives an account of a photograph taken by Herr H. L. van der Valk during a violent storm which occurred on July 15, 1896, at 10h. 30m. p.m. at Davos. The hand camera used was held during the exposure, which lasted some time, and several flashes were seen before the plate was eventually closed up.

The description of the photographs is as follows:—

"In addition to an ordinary ramified flash the plate shows a portion of another flash composed of a series of points. An examination of the photograph suggests that the points are equidistant from one another in

space, but appear at times closer together in consequence of the effect of perspective. When the points are apparently furthest from each other their distance on the plates is about one millimetre, and if it be assumed that the flash was one kilometre distant, the true distance between the centres of each point works out as about eight metres. On another occasion, namely, on December 9, 1895, van der Valk secured a somewhat similar flash to the one above described."

It is unfortunate that I have been unable to secure copies of these photographs, but failing these I am able, by the kindness of the editors of the *Meteorologische Zeitschrift*, to reproduce copies from the blocks which accompanied Professor Riggenbach-Burckhardt's description. The reader, by referring to these illustrations, Figs. 4 and 5, will see the punctuated appearance of these markings.

It is my impression, however, that in these instances we are not dealing with lightning flashes at all, but that the dotted streaks are due to impressions from some artificial light sources of an oscillating character, the images of which have been allowed to trail, owing to the movement of the camera. It has already been stated that the camera was held in the hand, so the explanation given above seems feasible on this account.

(*To be continued.*)

## Korn's Theory of Universal Vibrations.

By CHAS. A. HOSKEN.

THE really remarkable results lately obtained by Professor Korn with his telephotographic apparatus have brought his name conspicuously into the foreground; the present, therefore, seems a fitting time to review briefly some of the work done by the Professor in another branch of science. I refer to Korn's Theory of Universal Vibrations, which gives us a purely *mechanical* explanation for action at a distance, for instance, gravitation; in the following I propose to give a short outline of this theory.

The theory was first expounded in Professor Korn's book, "Eine Theorie der Gravitation und der elektrischen Erscheinungen," published in 1898; since then several new publications on the subject have appeared, a list of which will be found at the close of this article.

As a starting point for the theory, we can take the experiment made by Professor C. A. Bjerknes, of Christiania. Two hollow, india-rubber balls suspended in a fluid—for instance, water—are caused to pulsate periodically by pumping air in and out of the balls through small tubes. The balls will then attract one another if the phases of the pulsations are the same, that is to say, if both balls contract at the same time and also expand at the same time. On the other hand, if the pulsations have opposite phases, a repulsion takes place. This is a purely mechanical phenomena, and can be accounted for by the laws of hydrodynamics.

If, now, in place of the two india-rubber balls, we assume two particles of matter pulsating with like phases and periods, and in place of the water an incompressible, or nearly incompressible, medium, an attraction between the particles will likewise take place. In the first part of the above-mentioned book, Professor Korn studies the behaviour of such pulsating particles floating in an almost wholly incompressible medium, and with the help of hydrodynamic laws he shows that, assuming the distance between the particles to be very great compared to their radii, the particles will attract each other with a force varying inversely as the square of the distance between them. This, then, would give us a purely mechanical explanation of the force of gravitation.

The fundamental hypothesis of Korn's theory is the assumption that the universe, or, better, the solar system, is composed of two parts, one being matter, tangible, and accessible to our observation, the smallest particles of which are ceaselessly pulsating with like phases and periods, the other part being an almost wholly incompressible medium of small density, not accessible to our observation. The pulsations must further be assumed as exceedingly rapid, far more rapid than the vibrations giving birth to light, and the amplitudes must also be exceedingly small.

But why assume pulsations? And why must there be a medium?

The conceptions "matter," "time," and "space" alone are not sufficient to account for the known physical phenomena; further, the idea of mere empty space between two bodies makes a mechanical explanation of forces acting at a distance, such as, for instance, gravitation or electrical attraction and repulsion, impossible. Obviously, a particle of matter can only influence another particle if it is itself imbued with some form of energy, and the simplest assumption is an inherent vibratory energy of the particle; also some kind of conductor is necessary to transfer the energy from one particle to another. An example will make the value of such an hypothesis more apparent. The electrical phenomena were first explained by assuming two electrical fluids, having certain properties of attraction and repulsion; and, in fact, the most important discoveries in this branch of physics were made with the help of calculations based on this naïve hypothesis. Later on a new phenomena and a deeper insight into the nature of electrical energy made it necessary to discard the simple theory of the two fluids, but this in no way lessens the value of such a theory as a starting point. Newton formulated a theory of light with the help of an assumed new body or medium, which was, however, soon discarded in favour of the undulating theory, and this latter has lately again been superseded by the electro-magnetic theory of light. And in all branches of physical research a similar simple hypothesis was the starting point, preparing the way for mathematically exacter theories, and being superseded by these as soon as the progress of each science made this necessary. It would, therefore, seem that a theory explaining not only gravitation, but also many other physical phenomena, with the help only of well-founded mechanical laws, must deserve the greatest attention; and Korn's theory does this. All his calculations are based on the well-known and universally accepted laws of hydrodynamics; and the value of a mechanical foundation for such a theory will be apparent when we consider that no known physical phenomena stands in direct contradiction to these laws.

It will now be clear why we must assume the particles of matter imbued with some inherent form of energy, and also why some form of medium is necessary. A little consideration will also show why the vibrations must be in the form of pulsations, that is, periodical distensions and contractions. Gravitation is a force acting equally in all directions. A vibrat-

ing particle of matter, in order to exert a force in all directions, must vibrate in all directions, and such a vibration must obviously be a pulsation. Further, the medium must be almost wholly incompressible for the following reasons: A compressible medium would result in mutual repulsion between two bodies as soon as the intervening distance became greater than a half wave-length, and this is contrary to observation; on the other hand, an absolutely incompressible medium and the herefrom resulting instantaneous transmission of a pulsation through space is not admissible. Korn, therefore, assumes the medium to be so nearly incompressible that the resulting wave-lengths are very great in comparison with all distances within our solar system. The objection that the deduced law of gravitation is contrary to observation is herewith refuted, since our observation of the working of gravitation is limited to distances occurring within the solar system.

That part of the law of gravitation which teaches us that the attractive force is directly proportional to the product of the masses places no difficulty in the way of Korn's theory, if we assume that every material body contains a number of pulsating particles directly proportionate to its mass, and, further, that the central distances between the separate particles constituting each body are great in comparison with the size of the particles themselves.

There is a certain difficulty in imagining the particles imbued with inherent pulsations of like phases. Professor Korn overcame this difficulty in his first treatise by supposing a large space embodying the solar system to be subjected to a periodical pressure from outside; this would result, in consequence of the compressibility of the material particles and the incompressibility of the surrounding medium, in the periodical pulsation of all particles, the phases and periods obviously being the same for all particles. To illustrate this, Professor Korn repeated Bjerknes' experiment with a variation. Two india-rubber balls were suspended within a large copper vessel filled with water, one ball being fixed, the other movable. A periodical pressure was exerted by pumping water in and out of the vessel through small tubes, symmetrically arranged round the vessel. This arrangement made it possible to cause the balls to pulsate so rapidly and with such small amplitudes, that the vibrations were hardly visible to the eye; at the same time a strong attraction between the balls could be observed.

The fact that the hydrodynamic law for the attraction of the two pulsating balls only holds good as long as the central distance between the balls is great in comparison with their radii also finds its equivalent in the law of gravitation. As an example, we can take the mutual repulsion of the particles of a gaseous system (Maxwell's kinetic theory of gases); also the phenomena of elasticity and capillarity do not follow the general law of gravitation.

In his second treatise, "Eine mechanische Theorie der Reibung," Professor Korn departs from his former assumption of an external periodical pressure acting upon the solar system, and simply assumes the slightly compressible particles of matter to be pulsating with like phases and periods, surrounded, as before, by an almost wholly incompressible medium.

Now, every not wholly incompressible system—for instance, our incompressible medium with the embedded compressible particles—is capable of an infinite variety of modes of vibration; the vibrating string of a violin or other instrument embodies at one and the same time one mode of vibration for its fundamental tone, and also separate modes of vibration for the octaves, the number of modes being theoretically infinite. Those pulsations of our solar system which result in the mutual attraction of bodies, must be regarded as the fundamental vibrations of this system. The violin string will soon lose its vibrations in consequence of the action of friction; but in the case of the exceedingly rapid pulsations, causing the phenomena of gravitation, friction is a negligible quantity; these pulsations will continue for infinite periods of time. Also, these fundamental pulsations of the particles of matter must necessarily have the same phases and periods since they are connected with each other by an almost wholly incompressible medium.

As already mentioned, our system is capable of an infinite number of modes of vibration, and we have seen that the fundamental vibrations account for the force of gravitation. The study of the first overtone of the system leads to the result that the particles repel each other with a force varying inversely as the fifth power of the distance separating them. This force will not interfere with the attracting force of gravitation as long as the distance between the particles is comparatively great, but at a certain point the repulsive force exerted by the secondary vibrations will overcome the attractive force. This is a very important result, leading to a *purely mechanical interpretation of Maxwell's kinetic theory of gases*. If we go still further and examine the second and higher overtones, we find that these also give rise to apparent actions at a distance between the particles, and that the forces exerted are inversely proportional to a higher power of the distance, the higher the overtone in question. The second overtone results again in attraction, and this is also a very important point. It is known that if the particles of a gas approach each other more closely, the force of attraction again comes into play, and the gas finally assumes the liquid state. There can be little doubt that the forces of elasticity and cohesion may also admit of a mechanical interpretation, with the help of the higher overtones of our system.

Finally, Professor Korn is of opinion that the electrical phenomena are the result of vibrations of the same period as the gravitational pulsations (the fundamental vibrations of the system). In every electro-magnetic field the velocities are to be assumed in the form—

$$u = u_o + u_1 \cos \frac{t}{T} 2\pi + u_2 \sin \frac{t}{T} 2\pi$$

$$v = v_o + v_1 \cos \frac{t}{T} 2\pi + v_2 \sin \frac{t}{T} 2\pi$$

$$w = w_o + w_1 \cos \frac{t}{T} \pi + w_2 \sin \frac{t}{T} 2\pi$$

T being the period of the gravitational pulsations, which is exceedingly small compared with the period of light vibrations, and $u_o$, $v_o$, $w_o$, being ordinary visible velocities. The functions $u_1$, $v_1$, $w_1$, are proportional to the electrical components X Y Z, and the functions $u_2$, $v_2$, $w_2$, to the magnetic components L M N, of Hertz, Maxwell, and Lorentz.

Korn's theory thus gives us a mechanical explanation of the electro-magnetic phenomena, which is in every way as complete as the explanations of Maxwell and Lorentz, if we assume their fundamental formulæ as an hypothesis to work upon; but a purely mechanical theory should do more than this, it should allow us to formulate the fundamental formulæ upon a purely mechanical basis; this, however, still presents some

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difficulties. But in any case, Korn's theory will prove useful in conjunction with the theories of Maxwell, Hertz, and Lorentz, by helping us to gain a mechanical conception of electro-magnetic action; the ultimate object is naturally a purely mechanical explanation of the electrical phenomena; and Professor Korn asserts that the endeavour to elucidate mechanics with the help of the electron theory is contrary to all methods of natural philosophy.

A brief examination of one or two other theories in regard to their applicability to the force of gravitation may here be permissible.

One of the most popular theories is that of Le Sage, in which the gravitation of bodies is supposed to be caused by infinite multitudes of atoms (ultramundane corpuscles) bombarding the gravitating bodies from all sides. A material body alone in space will be subjected to an equally strong bombardment from all sides, but in the case of two bodies within measurable distance of each other, each body will act as a screen for the other, keeping off a certain number of bombarding atoms; therefore, a larger number of corpuscles will strike either body on that side which is turned away from the other body, thus urging the bodies towards each other. Strict dynamical reasoning soon proves this theory to be unsound; the impact of the corpuscles must be either elastic or inelastic, and in either case insurmountable difficulties present themselves when we approach the problem with the help of mathematical analysis.

Two theories of Sir William Thomson's (now Lord Kelvin) bear a certain resemblance to Korn's theory. The first, the well-known theory of vortex rings, presupposes space to be filled with an incompressible medium of uniform density, in which the vortex rings play the same part as the pulsating particles in Korn's theory, these vortex rings being imagined as the true form of the atom; in Thomson's theory, apparent action at a distance is also hydrodynamically explained. The recommendation of such an hypothesis would be that the division of space into matter and non-matter is altogether avoided. But it is no longer possible to maintain this non-division of space as soon as we come to the explanation of apparent action at a distance. To explain such action, Thomson assumes the apices of the vortex rings as the centres of action; but such apices can only exist at the surface of the incompressible medium, thereby necessitating the assumption of empty intermediary spaces in the medium; but this again leads us to a division of space into matter and non-matter. Thomson's theory is virtually, therefore, not incompatible with Korn's mechanical theory.

A second, and very interesting hypothesis of Sir W. Thomson's bears a still greater resemblance to the theory of universal vibrations. Sir W. Thomson (Proceedings of the Royal Society of Edinburgh, February 7, 1870) showed that if space is filled with an incompressible fluid or medium, and if all material bodies generate and emit this medium at a constant rate, the medium passing off into infinity, an attractive force between any two bodies varying inversely as the square of the distance separating them will result. The same result will be attained if we suppose the bodies to be continually absorbing the medium which flows in from outer space. This affords us a hydrodynamical illustration of action at a distance. But the conception of a body continually generating a fluid without any supply from outer sources is so contradictory to all experience that we can hardly consider this to be an explanation of the force of gravitation.

It is also interesting to note that Newton himself invented a theory to account for gravitation by differences of pressure in a medium; this theory was, however, never published, "because he was not able, from experiment and observation, to give a satisfactory account of this medium and the manner of its operation in producing the chief phenomena of Nature."

The following publications by Dr. Arthur Korn will be useful to those desirous of studying this most interesting theory of universal vibrations more fully: "Eine Theorie der Gravitation und der elektrischen Erscheinungen" (Duemmler, in Berlin, 1898); "Eine mechanische Theorie der Reibung" (same publisher, 1901); two short treatises, "Ueber eine moegliche Erweiterung des Gravitationsgesetzes" (published by the Royal Academy of Munich, 1903); and the treatise "Les vibrations universelles de la materie" (Annales scientifiques de l'école normale supérieure, Paris, April, 1903); and finally "Le probleme mathematique des vibrations universelles" (Communications de la Société Mathematique de Kharkow, 1903.)

## Dew-Ponds.

By EDWARD A. MARTIN, F.G.S.

II.

IT has been attempted with some success to attribute the first formation of dew-ponds to the Neolithic peoples in England, and this has been the view of various writers on the subject, the necessity very early showing itself to such people of having reliable water supplies when besieged or shut up, even though for a short time, in their hill-camps. But, as Pitt-Rivers has pointed out, the time during which such sieges lasted could not have exceeded a day or two at most, and I cannot help thinking that the ponds are more likely to have been constructed principally, if not entirely, for the watering of cattle, this being just as much a necessity in times of peace as in times of strife. The herbage found on the downs was then, there is no reason to doubt, just as sweet and wholesome as it is now, and our flocks are, by preference, still found in immense numbers on the Surrey and Sussex hills, although there are no marauding bands to waylay them nowadays in the lower lands near by.

It should be noted that Pitt-Rivers, in his notes on the Winklebury Camp excavations, 850 feet above sea-level, speaks favourably of the idea that these highly-placed camps may have been watered by springs which then ran at a higher level than now. And, of course, if there were a probability of this, we should have here important evidence in favour of some dew-ponds having been filled at one time by springs. But this could never have been so in the case of those ponds which are really at the very summit of the downs. Gilbert White referred to the fact that the water-line in chalk was always found at the same level in all the wells in his district, although recent observations in Yorkshire go to show that the water-line follows the contour of the chalk hills. We know that since so many private wells and borings have tapped the chalk under London, the water level has been steadily sinking. The chalk is sometimes likened to a sponge in the way in which it soaks up water, and if this be the case it will not yield surplus water until it has itself been saturated. But then, if the water-level be lowered, as we know it has been lowered, the chalk would still remain saturated if

we grant it this soaking power, although above that water-level it would not yield a supply which could be tapped by well-sinkers. In the olden days, therefore, it would not have been any more likely to have given rise to springs than now, and little more than the mere surface drainage, or that part which remained after percolation, would have gone to fill the ponds. Pitt-Rivers also points out that in many chalk districts "there are high springs which run only in the winter, when the hills have sopped up the winter rains, and retained them, like sponges, at the higher levels." ("Excava-

**Fig. 1.—Dew and Mist Pond, overlooking Waterall Valley, Patcham, Sussex. This is one of the best examples to be met with. The water is beautifully clear, and there is no drainage into it.**

tions in Cranborne Chase," Vol. II., p. 237.) But this can have no reference to summit-ponds, although the statement is quite true, and was probably considerably more so in former times, when forests and woods existed which have since been cleared. Still, if these springs merely flow because the water which supplies them cannot sink into saturated chalk, then the ponds which they feed have no special reason to be called "dew-ponds" at all.

Yet, as White informs us, these strange little ponds on the tops of the hills are full when those in the bottoms are dried up; that is, in times when there has been a dearth of rainfall, and this, although it is admitted that the water-level in the chalk has sunk as compared with earlier times. And, as Johnson and Wright say, even in our times the strange spectacle is sometimes seen "of carts being sent up hill to procure water for the granges and bartons in the vale." Besides, Mr. J. C. Clutterbuck refers to the fact, evidently admitted so recently as 1865, that the tops of chalk hills are often chosen for sites, where no surface-water except rainfall can furnish a supply. Therefore, as White says, there must be "some unnoticed recruits, which in the night-time counterbalance the waste of the day."

What are these recruits? As the ponds have come somehow to be known as "dew"-ponds, it will be well first of all to consider whether dew is one of these recruits. H. V. Slade dismisses at once the possibility of it acting as such. It must be borne in mind, however, that he particularly referred to the one pond only, and in that the straw was laid on the clay or puddle, and the only object of the straw was, according to his statement, with a view "to prevent the sun cracking the clay." He did not suggest that the straw was of use in keeping the water of the pond cool. But Hubbard says that the purpose of putting the straw *under* the puddled clay is to prevent the clay receiving heat from the earth which the latter has absorbed during the warmth of a summer day. At the same time the puddled clay is chilled by the process of evaporation, and the straw acting as a non-conductor, the moisture contained in the warmer air is deposited in the form of dew. In this way an empty pond will become filled without other assistance, the condensation during the night being in excess of the evaporation during the day, until, presumably, the margin of puddled clay around the pond becomes smaller and smaller, and dew deposited thereon ceases to recruit the pond.

In the meantime, as pointed out by Professor Miall, although water itself is a bad conductor of heat, the surface of a pond would cool by radiation (very slowly), and in cooling would, of course, become denser. The layer at the surface would, therefore, sink, and give place, by convection-currents, to water not yet cooled to the same extent and, therefore, less dense. The process of replacement being continued, the net result may be that the whole mass is cooled sufficiently to chill the superincumbent air below the dew-point. In this way a dew-pond, if built on Hubbard's plan, and granting the principles advanced by them, would, after becoming filled without artificial assistance, continue to receive dew (invisible mist, as I have called it) when partially filled, although the greater part of the clay were covered.

Clutterbuck, on the other hand, says that the water must, in the first place, be introduced by artificial means, but in this case we must remember that the straw was placed over the clay, and it was not claimed that the straw in any way attracted the deposition of dew. As Miall says, this seems to be decisive against the sufficiency of rainfall alone, in so far as such ponds are built after Clutterbuck's plan.

Clement Reid states that "the open downs, even in the middle of summer, receive much heavier dews than would be expected, or than are met with on the low-lands." But he adds that "thick sea-mists often cling

**Fig. 2.—Mist-Pond on Riddlesdown, Surrey, situated at the top of the Down. There is some drainage from a road.**

to their top [of the open downs] for several hours after sunrise, while the plains below are already dry and sunny." This brings us to the question of mist acting as a recruiting agent, and one cannot help thinking that this may be of material benefit to the pond.

The claim that dew alone is the great cause of the permanence of such ponds receives a shock from an experiment conducted by J. G. Cornish at Lockinge, in Berkshire, and recorded in C. J. Cornish's "Naturalist on the Thames." The temperature of the water in a dew-pond on Lockinge Downs on July 16, 1901, was 20° F. higher than the temperature of the air. Dew, could not, therefore, have been deposited, since the

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temperature would probably have been maintained throughout the night, but if not, the difference in temperature of the water and of the air would, at any rate, have been accentuated. This would be in accordance with the principle that water, although it takes longer to warm, yet when once it acquires a certain temperature it retains its heat without materially warming the air above it. Water has far less absorbing and radiating power than dry land, and, therefore, would have less effect on the air above it. Mr. K. H. Scott states that "as the specific heat of water is five times that of dry land, it takes five times as much heat to raise a given mass of water through a given range of temperature as it does to raise an equal mass of dry land."

Mr. Cornish also records that, on the other hand, five days of heavy dew in April and May, with no fog, raised the level of the same pond no less than 3½ inches. This record is so extraordinary that one hesitates to give it credence, and further similar observations are desirable. Attempts have been made from time to time to measure dew-fall, and Mr. G. Dines, in a paper "On Dew, Mist, and Fog," gave the average of his observations at 1.397 inches, or on the grass alone at 1.022 inches. "Making a liberal allowance for contingencies, it may, I think, be fairly assumed the average *annual* deposit of dew on the surface of the earth falls short of 1.5 inches." What, then, are we to say to a reported deposit of 3½ inches in five days?

One can scarcely help admitting that the positions of the ponds which are known favour the fact that fogs do add a certain quantity of water to them. The experiments of Mr. Cornish, or, rather, of the shepherd whom he engaged, are very striking. After a night of fog, the surface of his pond was found on January 18 to have risen 1½ inches; the next day, following another fog, gave 2 inches; and on January 24 an inch was measured. It was not recorded what was the principle on which the bottom of the pond was laid.

**Fig. 4.—View across pond on Riddlesdown, showing position on top of Down.**

If mist be admitted as a valuable agent in recruiting the ponds, then it is a fit subject for enquiry as to what steps should be taken to encourage the deposition of the mist as water. White admitted that an overhanging beech or other tree was of importance in connection with some of the ponds around Selborne. Clement Reid thinks that an overhanging tree on the side nearest the source of the moisture-laden currents of air is of importance. "When a sea-mist drifts in," in early morning or towards evening, "there is a continuous drip from the smooth leaves of the overhanging tree."

The position of the pond now becomes of importance, and if the pond has a high southern or south-western bank it seems to act in a favourable way in causing fog to precipitate its moisture.

The Sussex Downs are the home of the dew-pond, and many a time for the whole of a day I have walked through dense fogs which have rolled in from the sea, and have finally taken their flight, as from a jumping-off ground, along the northern ridge of the downs between the Dyke and Plumpton. The trees, where there are any, such as the Holt, near Clayton, will then be

**Fig. 3.—Mist-Pond depression on the alignment of the old British rampart at the top of Ditchling Beacon, Sussex; it is now empty.**

seen and heard dropping water on to the leaf-soil below, whilst one's own garments become damp and clammy.

One does not like to part from the idea that dew-ponds have been correctly so named, but there is no direct proof that they are so. On the other hand, there is a good deal to throw doubt upon its correctness, since no pond, situated as they are, could fail to receive a great deal of condensation from mists.

But I am strongly inclined to think that the use of straw may have a good deal to do with the attraction of moisture to a pond. It is used in India to produce a low temperature and so obtain ice in the open, at night-time. Mr. T. A. Wise has described (*Nature*, Vol. V., p. 189) a method by which quantities of ice are obtained in the neighbourhood of Calcutta. An excavation of the ground to the depth of two feet is made. This is filled with rice-straw to within six inches of the surface, somewhat loosely laid. Shallow pans of porous earthenware are then filled with water, and as long as the air is comparatively still the ice forms in the pans. The straw is a powerful radiator, and, being kept loose and dry, prevents the heat rising from the earth to the water in the pans. Heat is cut off both top and bottom, and it is stated that the temperature of the air in contact with the dishes is reduced some 20° below that two or three feet higher up. This practice certainly seems to throw some light on the use of straw at home.

One thing, at any rate, is certain, that mists contribute largely to these ponds. What we need now is a scientifically-constructed pond on Hubbard's principle as a first experiment. At present I know of no other direct and unqualified statement as to what a dew-pond really is, how it is constructed, and why it attracts the dew, and it might, I think, be put to the test. Then if it were successful in collecting water, with no artificial introduction of a supply in the first place, meteorological observations might follow to show, if possible, the laws which were most potent in accomplishing it.

## New Light on the Analogy Between Gases and Solutions.

By JAMES C. PHILIP, M.A., Ph.D., D.Sc

IT is now some twenty years since Professor van't Hoff published his striking paper on the analogy between gases and dilute solutions, and the extraordinary activity displayed during the last two decades in the investigation of the properties of solutions is largely due to the stimulus supplied by that memoir. Quite recently, some very important work has been carried out, partly in England, partly in America, on the osmotic pressures of aqueous solutions, and since osmotic pressure was the property of solutions which figured most largely in van't Hoff's paper, it is extremely interesting to examine his conclusions in the light of these recent investigations.

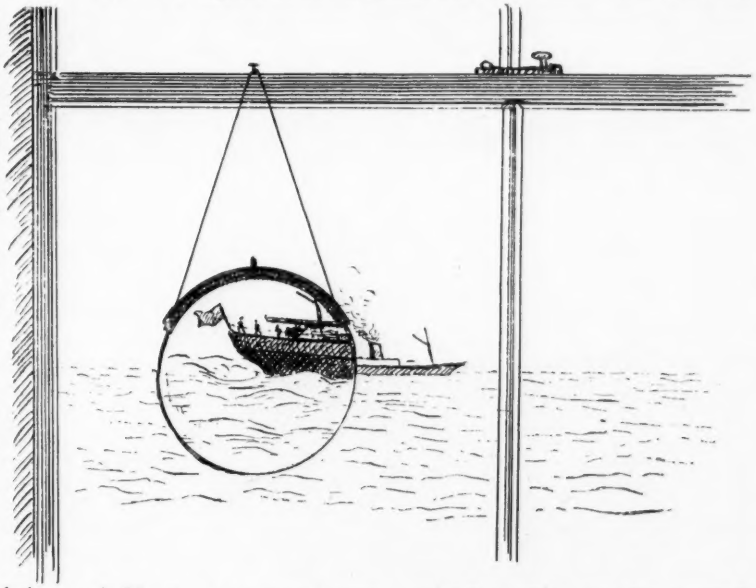
According to van't Hoff, the osmotic pressure of a solution, just like the pressure of a gas, varies proportionally (1) to the concentration, and (2) to the absolute temperature; further, the osmotic pressure exerted by a dissolved substance in dilute solution is equal to the pressure it would exert if it were in the gaseous state at the same temperature, and occupied the same volume as the solution. These conclusions were established largely on theoretical grounds, and the experimental material then available for their verification was somewhat scanty, the only direct measurements of osmotic pressure made before 1887 being those carried out by Pfeffer, professor of botany at Basle. This limited experimental foundation of van't Hoff's conclusions led to a sceptical attitude on the part of many chemists, and it must be admitted that his conception of osmotic pressure as due to the impacts of the dissolved molecules on the semi-permeable membrane made far too little of the part which is undoubtedly played by the solvent in all osmotic phenomena.

Apart, however, from all speculations as to the origin of osmotic effects, it is of the greatest interest and importance that recent work has confirmed and extended the conclusions reached by van't Hoff twenty years ago. It must always be remembered that, according to van't Hoff himself, these conclusions were valid only for dilute solutions, and the modifications which recent work has shown to be necessary are the consequence of extending the ground so as to include concentrated solutions. The osmotic pressures of cane sugar solutions have lately been determined by Lord Berkeley and Mr. Hartley, in England, and by Messrs. Morse and Frazer, in America, and the results obtained by the last-named investigators bear directly on the analogy between gases and solutions. Working with fairly concentrated solutions, from 0.1 to 0.83 normal, they found that the osmotic pressure varied proportionally (1) to the concentration, (2) to the absolute temperature, provided that the concentration were referred not to one litre of solution, but to that volume of solution which contained 1,000 grams of solvent. They have further shown that cane sugar, dissolved in water, exerts an osmotic pressure equal to that which it would exert if it were gasified at the same temperature and the volume of the gas were reduced to that of the solvent in the pure state. The similarity of these propositions to the conclusions reached by van't Hoff will be obvious at once, and their significance becomes identical for dilute solutions.

The results, therefore, obtained by Messrs. Morse and Frazer are of the utmost importance as broadening the basis of the gas theory of solutions, and, more generally, as indicating one factor at least for which allowance must be made in considering the properties of concentrated solutions. Already, indeed, the method of referring concentration, not to one litre of solution, but to 1,000 grams of solvent, in other words, the use of *weight-normal* solutions in place of *volume-normal* solutions, is yielding interesting results in other fields than that of osmotic pressure.

## A Large Size "Unilens."

IN our number for October last was described a small instrument, known as a "Unilens," designed by Major Baden-Powell for magnifying objects at a distance; in fact, forming a simple kind of telescope. This little glass is only 2½ inches diameter, but recently a much larger glass on the same principle has been brought out. This is 7 inches diameter, and when mounted at a distance of about 12 feet from the eye, enables distant objects to be magnified fully six times. It is provided with a small screw projection which can be screwed into any tree, post, or other support, or it can be fixed on to a special tripod. The instrument is also provided with rings, so that it can be hung by a string, picture-like, in front of a window. The illustration gives an idea of the general appearance of the appliance when hung in a window, and shows how a portion of a passing ship may be seen greatly magnified.



This larger glass has a great advantage over the smaller one, in that it is adaptable to almost all eyesights (although some people will need to stand closer to it than others). This instrument should prove useful for a great variety of purposes.

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# Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

**Photography of the Infra-red.**

There are several methods by which the infra-red of the spectrum may be recorded. Direct photographic methods with colour-sensitised plates, giving exposures of not abnormal length, will give by means of pinacyanol as far as about wave-length 7,600 (the A line), and with alizarine blue S to about 8,300 or, perhaps, 8,900, according to the condition of the dye. Abney, by means of a specially prepared collodion emulsion, worked as far as 10,000, and his emulsion was sensitive to about 20,000.

Last November I referred to experiments by G. Millochau, in which he took advantage of the reversing action of the infra-red, fogging his plates before exposure to the spectrum. He worked to about wave-length 9,325. Since then he has continued his work and mapped the solar spectrum as far as 9,500. More recently H. Lehmann has utilised the property of the infra-red of extinguishing phosphorescence. He uses a screen of phosphorescent zinc sulphide, excites it, exposes it to the spectrum, then immediately places it in contact with a green-sensitive photographic plate. After due exposure the plate is developed as usual. By this means he has photographed the spectrum as far as 20,000. He found that it was necessary to have lenses specially corrected for this part of the spectrum, because the defining power of lenses corrected in the ordinary manner fails at about 9,000. The transparency of the glass used was found to be such that it transmits up to about 30,000, so that there is room for further work in this direction without discarding glass apparatus. By the use of prisms and lenses made of rock-salt and bolometric methods, that is, determining the variations of temperature by electrical means, Langley has mapped the solar spectrum about as far as 55,000, and finds indications of action very much further. Whether photographic methods will ever be available in regions so remote from visible light is an interesting question not yet solved.

Meanwhile the old idea, founded to a certain extent upon fact, that light has a three-fold character, producing either chemical action, light proper, or heating effect, and that while the last is associated chiefly with the infra-red the violet and beyond constituted the especially "chemical rays," is being shown to present a very incomplete idea of the facts of the case. The photographer can already extend his work into the ultra-violet until even the air contained in his apparatus has to be removed because of its opacity to the radiations in that remote part of the spectrum, and there can be very little doubt that photographic methods will eventually be carried further and further into the infra-red.

**Reversal and Re-reversal.**

M. E. Demole, in the *Comptes Rendus* for March 11 last, describes some interesting results in connection with the action of weak oxidisers and over exposure on the developable image. He employs Lumière's "blue label" plates, and finds that if, after exposure, the plate is soaked for a few minutes in a 1 per cent. solution of potassium ferricyanide and rinsed before development (he uses a hydroquinone developer), very considerable over-exposure is not detrimental to the result, nor does it even quicken development. If, however, the plate is developed by the light of a naked candle, the image is reversed, an effect that was described years ago, though, I think, without the use of an oxidising bath. But the most interesting observation is that by still further prolonging the exposure the image is re-reversed. He gives an actual example. A plate was exposed under a negative for one second, developed in the dark-room as usual, and gave a satisfactory positive. By treating the exposed plate with the weak ferricyanide solution and developing by candle light, exposure of from one to 170 seconds gave negatives, and at 180 seconds re-reversal commenced to show itself, the image appearing at first as a positive, and passing to a negative on continued development. An exposure of 420 seconds gave a somewhat fogged positive, but twice this exposure (840 seconds) gave a perfect positive. I have given the figures in seconds, as they represent the number of times that the normal exposure was multiplied by, but not including the subsequent illumination to candle light.

One would like to know whether the candle light during development might not have been replaced by a definite exposure to a similar light before development, and the effect of varying the duration of this exposure. The amount of illumination that the plate receives during development by candle light is very uncertain. But that is a mere detail. The chief fact is that two reversals were obtained—first a positive, second a negative, and third a positive, and that each result was good and apparently would be practically serviceable. A first reversal is common enough, but a second, though sometimes observed, has often been tried for unsuccessfully. This second reversal is a great stumbling block to those who formulate theories of the nature of the developable image founded on the assumption that the silver bromide is chemically changed by a normal exposure. M. Demole's hypothesis, which only seems to account for the first reversal, will surely not commend itself to many, for he suggests the formation of an oxybromide of silver, which he formulates as the hypobromite, together with silver hydrate.

**Received.**

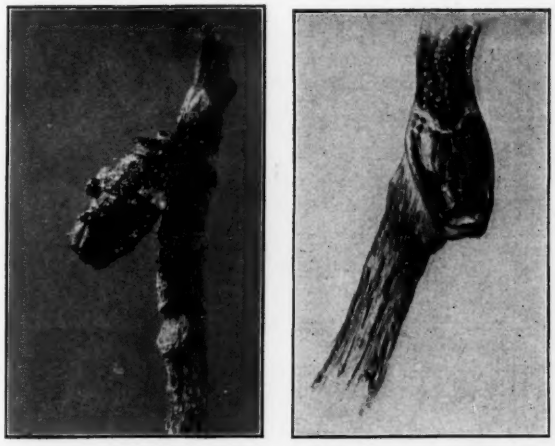
"Agfa Isolar" and "Agfa Chromo Isolar" plates. The first are somewhat sensitive to green, and the second considerably more so, but the especial feature of these plates is a dyed red film between the sensitive film and the glass, that prevents halation, even with long exposures. A film of this kind is far more effective than ordinary backings brushed on in irregular streaks. Giving an image free from halation, and having a fine and even grain, these plates are to be recommended when fine detail has to be rendered, as in photomicrography and in astronomical work. With the "Chromo Isolar" plates, a yellow film screen is enclosed that necessitates the exposure being increased to about six times.

The "Goerz-Anschutz Folding Camera." I have examined an example of the most recent form of this excellent instrument. It has lately been improved in two or three details. The focal-plane shutter is so arranged that when being wound up for setting, the two margins of the opening overlap and so obviate the need to cap the lens to protect the plate. In addition to the more rapid exposures, provision is made for exposures of from half a second to five seconds by means of an air-brake (a plunger in a cylinder) which is inside the shutter. All adjustments are made outside the camera and may be made, if desired, after the shutter is set.

## The Royal Society Soirée.

THE first of the two scientific *soirées* annually given by the Royal Society was held on May 8 last at Burlington House. We append some particulars of the more noteworthy exhibits in various departments of science, together with a series of illustrations, the latter of a specially interesting character. The *soirée* was acknowledged to have been considerably above the average in respect of the variety and novelty of the exhibits arranged for the inspection of visitors.

In natural science the Marine Biological Association was responsible for a select representative collection of living sea-weeds, illustrating the habits, growth, and reproduction of the marine algæ of the Plymouth district. Some attention is now being given to this class of inquiry at the laboratory on Citadel Hill. From the Natural History Department of the British Museum came various interesting exhibits, perhaps chief among these a stuffed specimen (male) of that rare animal, the Okapi, obtained from the Ituri Forest, Congo State, by Major Powell-Cotton, who himself was present at the



**Figs. 1-2.—Chrysalis (attached to a twig) of a moth (*Binsitta barrowi*); and head of tree-snake (*Lycodon aulicus*).**

*soirée*. The specimen was sent across from Mr. Rowland Ward's establishment, where it had been set up, but it is now in position in the Cromwell Road gallery, a gift from Major Powell-Cotton. The Museum of the Royal College of Surgeons exhibited, through Professor Charles Stewart, F.R.S., a number of biological objects. The pupa of a species of diurnal moth had an instructive story of its own to tell in the mode in which, attached to a piece of twig, it is specially defended by a rampart of hairs arranged partly in whorls. Examples of commensalism, and of symbiosis; a section of a snake's eye (*Python*), and the membranous labyrinth of a monk fish were included in an attractive series. We are inclined to think that the results of the scientific work actively carried on in this fine museum are by no means so well known to the public as they should be. The impression of many persons that monstrosities in bottles form the principal features is a misconception. The Museum provides, in fact, an important centre for biological study. Colonel Bingham brought the pupa of a rare moth, *Binsitta barrowi*, Bingh., belonging to the family Tineidæ, lately discovered by Colonel Waller-Barrow, R.A.M.C., at Maymyo, a hill station near Mandalay, Upper Burma (Figs. 1-2). The peculiarity of the chrysalis is that it bears a curious resemblance to the head of a bird-eating snake, *Lycodon aulicus*, Linn. Colonel Barrow was fortunate enough to find the moth just issuing from the pupa. In the opinion of the exhibitor, it is impossible to say whether the likeness is really protective or not, since no observations have been made with regard to the behaviour of birds in their wild state when encountering objects of the kind under reference. And experiments with captured birds or lizards are not conclusive, as the conditions are not normal. Professor W. B. Bottomley, of King's College, sent specimens of cultures and material used for soil and plant inoculation—"nitragen," "nitro-culture," &c. Mr. Fred Enock, F.L.S., transported, and showed by means of his microscope, living ovivorous parasitic hymenoptera (Mymaridæ). How infinitely little among winged insects are certain of the Mymaridæ may be realised in the computation that six of *Alaptus minimus* could walk through, abreast, the space of an ordinary pinhole. The insects and other orders of invertebrata found with ants in Britain, and their hosts, also microscopic exhibits of acari and coccidæ in fellowship with ants, found an exponent in Mr. H. St. J. Donisthorpe.

Sir Benjamin Stone, M.P., sent a series of photographic views illustrative of the antiquities and social customs of Egypt and the Soudan at the present time, aptly termed history pictures, taken by himself during the recent winter season. Many and varied were the subjects that engaged his camera. For instance, one saw a book cover of Sultan Moid, 15th century; the representation of a cattle show in the time of Rameses II.; a ceremonial procession of the "Mahmal" and

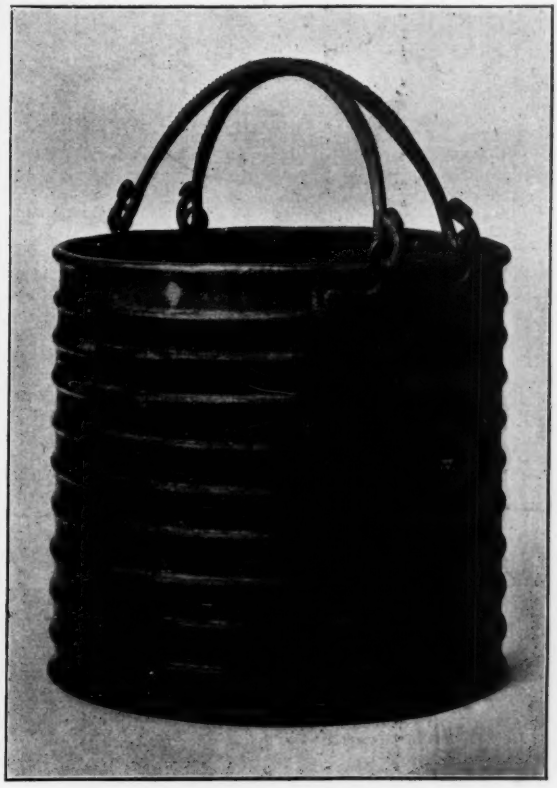


**Fig. 3.—An Ancient Bronze Bucket.**

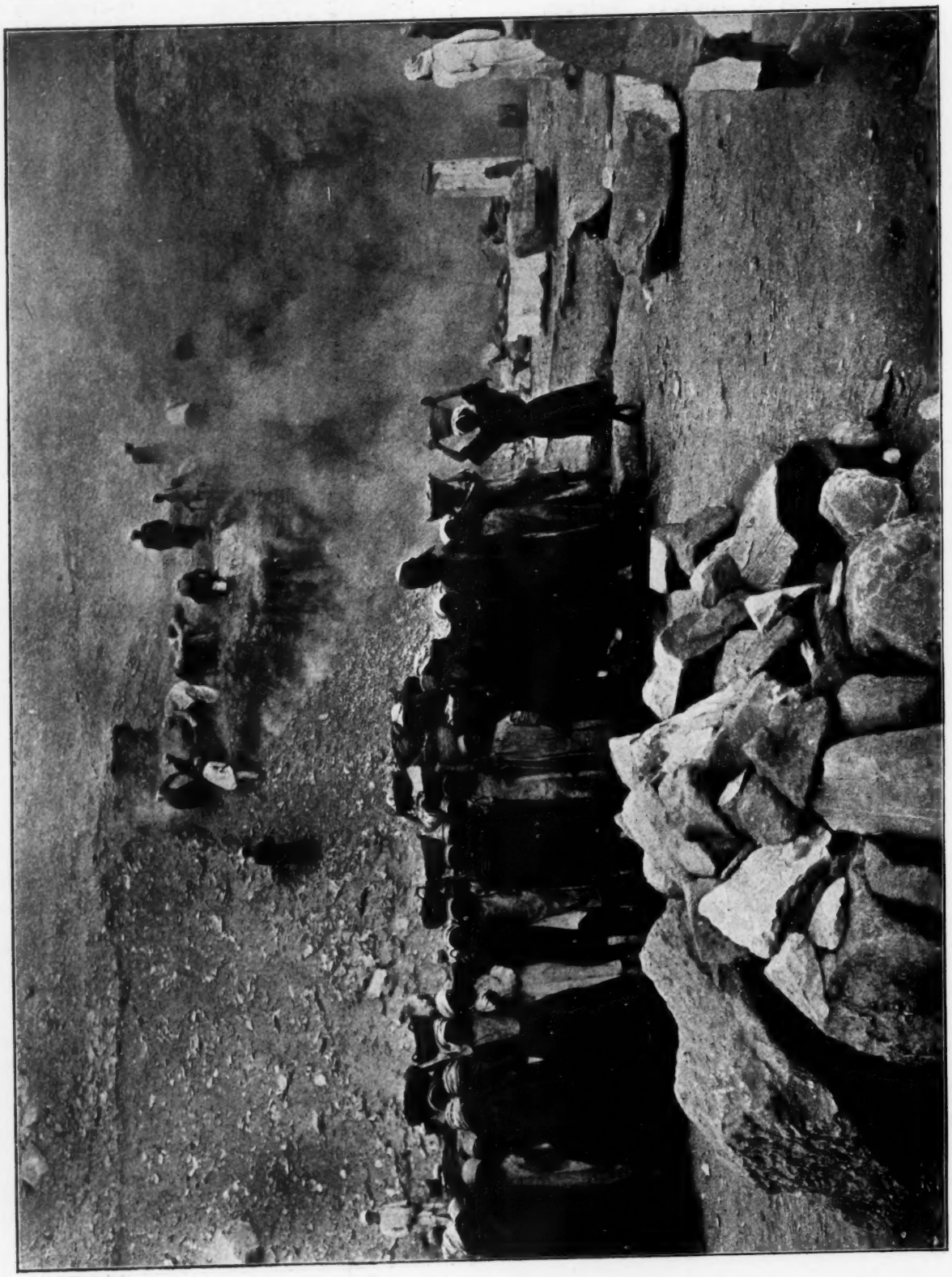


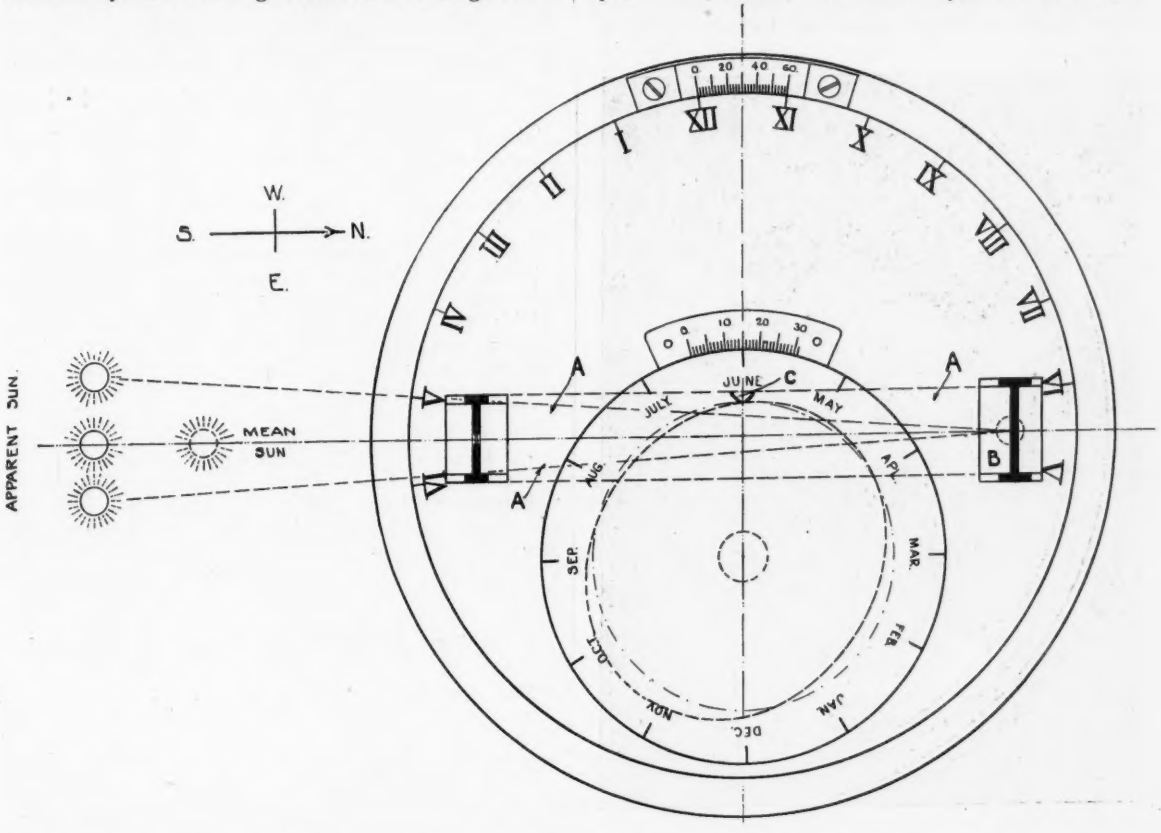
Fig. 4.—Excavations of Messrs. Naville and Currelly at Deir-el-Bahari, January, 1907. "The Carriers and Dust."

*By permission of]* *[Sir J. Benjamin Stone.*

pilgrims going to Mecca, Cairo (December, 1906); a street in old Cairo; and the exploratory work at the opening of a royal tomb, Deir-el-Bahari (Fig. 4). Mr. W. Dale, F.S.A., contributed a cordoned bucket of bronze, *circa* 700 B.C., found a Weybridge in April last, at a depth of 10 feet, whilst sinking a shaft for the pier of a bridge near the river (Fig. 3). The relic is to go to the British Museum, and it is interesting to mention that a bucket of precisely similar pattern is already in the collection. The present one is, however, the first of the kind found in Britain, and the Museum receives thus a notable addition. The bucket is of North Italian manufacture, of a type known as the "Halstatt" cemetery. This latter is situated in a defile of the Austrian Tyrol, in the neighbourhood of a village of the same name, and, from time immemorial, has been the scene of extensive salt-mining. Excavations were carried on in the burial ground of the old salt-mining community between 1847 and 1864, yielding rich results, over 6,000 objects being obtained. The earliest remains from this cemetery go back about 10 centuries before our era (consult "Guide to Early Iron Age," British Museum). It has quite recently been proved that some brooches, in museums and private hands, found in England, must have come from North Italy in the early Iron Age of Europe. On the strength of this, it has been asserted that there was commerce between Europe and Britain as early as 700 B.C., and the theory is confirmed in a remarkable way by the discovery of this bucket.

In the department of physics much interest was evoked by Sir James Dewar's novel experiments showing the cessation of action of a Crookes radiometer in very high vacua, the latter brought about by charcoal cooled in liquid hydrogen, or liquid air. Motion is arrested even when the instrument is subjected to the concentrated radiation of an electric lamp. A radiometer filled with the gas helium at atmospheric pressure, inactive to a charcoal liquid-air vacuum, becomes active in a charcoal liquid-hydrogen vacuum. A great deal of attention, too, was paid to an exhibit by Dr. J. T. Bottomley, F.R.S., and Mr. F. A. King, comprising demonstrations with vacuum gold leaf electroscopes. The gold leaves of the vacuum electroscope diverge when illumination of any kind falls upon them, and stand permanently apart when placed in bright daylight. By suitably manipulating such sources as a spirit flame, candle, or Nernst lamp, near the electroscope, forces which vary in direction and magnitude from point to point within the enclosure are generated, and cause the leaves to be twisted into curious shapes. The gold leaves will remain in this contorted condition for a considerable time after the exciting cause has been removed. Gold leaves hung in unexhausted enclosures were also exhibited for the sake of comparison. Mr. A. Kershaw's interesting new visual method of measuring the speeds of photographic shutters was, we think, lately heard of at the Optical Society. The Cambridge Scientific Instrument Company showed a portable electrometer, designed by Mr. C. T. R. Wilson, F.R.S. It had fused quartz insulation.

The Hon. Charles A. Parsons, F.R.S., provided photographs, highly magnified, of microscopic diamonds obtained from pure iron that had been heated in a carbon crucible in an electric furnace and rapidly cooled. We wish we could let our readers know more



respecting the mode of formation of the gems, but Mr. Parsons is reticent on the subject for the present. A mineral survey of Northern Nigeria is now in progress under the auspices of the Imperial Institute, and some typical examples were shown, together with new or exceptional minerals from Ceylon, of which more will be heard shortly through the medium of papers. The Thermal Syndicate, Ltd., Wallsend-on-Tyne, placed on view various articles, such as crucibles, muffles and trays, pyrometer protecting tubes, and so forth, made of fused silica, and manufactured by an electric furnace process at a temperature of about 2,000° C. In one form of use, namely, as an electrical insulator, the material is claimed to be superior to glass, porcelain, and similar materials. Apparatus of fused silica, as well as of malleable iridium and rhodium, were also shown by Messrs. Johnson, Matthey, and Co., of Hatton

**Fig. 5.—A Helio-Chronometer; illustrative diagram on previous page.**

Garden. As regards products of the latter, this firm have succeeded in rendering these hitherto practically unworkable metals so malleable as to permit of their being adopted for the manufacture of various laboratory requisites, such as tubes, basins, and flasks. Possessing a very high melting point, and being almost unaffected by acids, a field of extreme usefulness will undoubtedly be served by these interesting productions. The specimens of various forms of apparatus, fashioned of fused silica, were, it may be mentioned, manufactured by a process which allows of the production of transparent articles.

Astronomy was represented by two series of spectro-heliograms, and stellar spectrograms, from the Solar Physics Observatory, South Kensington. Messrs. Pilkington and Gibbs, Ltd., of Preston, exhibited a helio-chronometer (Fig. 5 and diagram on previous page) or amplified sun-dial. It is intended as a standard of reference for correcting clocks and watches at convenient intervals, say once or twice a week. It comprises devices for adjustment in latitude, longitude, level, and azimuth, and has an hour circle and a year circle. The hour circle or disc slides round on the upper part of the stand; a spot of sunlight is cast through a small hole in the upper screen on to a centre line scribed on the lower screen. When the spot of light is on the line, Greenwich mean time is clearly indicated by that division mark on the periphery of the hour circle which is adjacent to the minute sector on which are numbered divisions to show the minutes. The instrument is constructed entirely of gunmetal.

Demonstrations were given in the meeting-room by Mr. Louis Brennan, of his ingenious and probably commercially adaptable mono-railway; by Dr. Seligmann, of native dances taken in the course of the Daniels expedition to British New Guinea; and by Dr. Hele Shaw, F.R.S., of aëroplanes and machines for soaring and gliding. So much has been written already, elsewhere, with reference to the mono-railway that it seems scarcely necessary to say more here than that stability and equilibrium in the system are maintained by mechanism involving the use of two gyroscopes. Those who would navigate the air are boldly promised assistance by the principle which dominates the mono-railway. In this connection, we must not omit to refer to an important exhibit by Dr. Otto Schlick, and Messrs. Swan, Hunter, and Wigham Richardson, Ltd., of working models showing the application of gyroscopic appliances in steadying ships; in other words, allaying the rolling of big craft at sea, due to the action of ocean waves. In the opinion of Sir William White it is possible that gyroscopic steadying apparatus may hereafter find service in ocean-going passenger steamers, and it may be anticipated that experiments will be made before long with such apparatus in destroyers and in the smaller class of cruisers.

## A Curious Relation of Summer Rainfall.

Mr. Alexander B. MacDowall writes:—The first three months of this year were all dry (at Greenwich). Looking through the record, from 1841, I find twelve similar cases; and in ten of these years the summer following was dry (rainfall under average). Here is the list:—

| | Year. | Rainfall. Summer. | Relation to Average (6.75). |
|---|---|---|---|
| 1 | 1847 | 4.12 in. | − 2.63 |
| 2 | 1850 | 5.52 ,, | − 1.23 |
| 3 | 1854 | 5.27 ,, | − 1.48 |
| 4 | 1859 | 5.83 ,, | − .92 |
| 5 | 1874 | 6.45 ,, | − .30 |
| 6 | 1878 | 10.26 ,, | + 3.51 |
| 7 | 1882 | 5.97 ,, | − .78 |
| 8 | 1884 | 4.68 ,, | − 2.07 |
| 9 | 1887 | 4.87 ,, | − 1.88 |
| 10 | 1895 | 5.74 ,, | − 1.01 |
| 11 | 1898 | 3.95 ,, | − 2.80 |
| 12 | 1902 | 7.12 ,, | + .37 |

The exceptions are 1878 and 1902. We might perhaps note that these are about sunspot minima (1878 and 1901), which have been, since the sixties, relatively wet times (on the average.)

Will the approaching summer conform to the ten, or the two? I commend the matter for observation.

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## Practical Aerodynamics
### And the Theory of Aeroplanes.

By MAJOR B. BADEN-POWELL.

V.—SUPERPOSED PLANES.

ONE very curious and interesting result obtained by Dr. Stanton was as regards the *shielding effect* of one plane in front of another. He found that with two equal-sized planes mounted on the same spindle, when very close together the total pressure was slightly greater than on the single plane. But when the back plane was moved until at a distance equal to about half its diameter, the pressure *lessened*, and continued to decrease as the plates were moved further apart, reaching a minimum when at about 1½ diameters. The value of the total pressure when at that distance apart being "less than 75 per cent. of the resistance of a single plane." This result is probably caused by the pressure on the back plane nullifying the effect of negative pressure on the back of the front plane. As the planes were put still further apart the total pressure steadily increased, so that at a distance of 2.15 diameters the pressure was again equal to that on a single plane. But, though the pressure increased on further separting the planes, the shielding effect was well maintained up to a distance of five diameters, where the total pressure was only 1.78 times that on a single plane. Precisely similar results were got with other shaped planes. This is an important fact to take into consideration when designing apparatus with superposed surfaces. According to this theory, if two parachutes were attached one above the other at a distance equal to 1½ times their diameter, the whole would fall much faster than a single parachute.

Langley made experiments with superposed planes, but these were practically all made with the apparatus in horizontal motion, which gave rather different results. In one instance, to be found among his tables, a pair of planes 15 inches by 4 inches, fixed 6 inches apart, fell vertically at a speed practically the same as single planes of the same area. When at 4 inches apart they fell slower.

When the arrangement of superposed planes is moving horizontally the air between them is less affected, being continually renewed.

Langley's conclusions were that, with planes 15 inches wide by 4 inches front to back, when 4 inches or more apart they do not interfere with one another, and the sustaining power is, therefore, double that of single planes. But when placed only 2 inches apart there is a very perceptible diminution of sustaining power, and a greater rapidity of fall. The amount to which the distance apart of the planes affects their action is, of course, dependent upon the rate of translation, and the higher the velocity, the greater may be the proximity of the planes. The general conclusion is that superposed planes, in order to be efficient, that is, to give the effect of the total area of the surfaces, should be at a distance apart at least equal to their width from front to rear.

It will be remembered that Wenham many years ago (*Aëronautical Soc. Report*, 1866) constructed an apparatus with many superposed planes, which were placed at a distance apart equal to their widths (3 inches).

# NOTES.

## ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

### Temperature of the Planet Mars.

IN a recent communication to the American Academy of Arts and Sciences, Professor Percival Lowell discusses the probable temperature conditions of the Martian surface, in the course of which he introduces several novel considerations which have not received attention by previous workers on the same problem. Up to the present time the chief obstacle to the acceptance of the belief in the existence of life on the planet has been the extremely low surface temperature which has been assumed to exist. In the estimation of this, however, it has been customary to only consider the planet's distance from the sun as the factor; in this way Moulton, by the application of Stefan's law of radiation, found the value — .33° F. for the mean temperature. Professor Lowell insists that the planet's distance is only one of several determining factors, and proceeds to discuss minutely the effect of the planet's albedo or reflecting power, the screening action of any clouds which may be present, and the protective value of whatever atmosphere exists. After a discussion of the investigations on solar radiation at various altitudes, by Langley, Very, and others, and taking the Earth as being 50 per cent. cloud-covered, the Earth's mean albedo is taken as 0.75, and that of Mars is computed to be 0.27. Applying now Stefan's law, and including the effect of albedo, the mean annual temperature of Mars is found to be 72° F. or 22° C. This would correspond to the conditions if the heat were retained on Mars to the same extent as it is on the Earth. The retentivity is not the same, however, being greater on the Earth on account of its denser air covering, and the inclusion of this factor brings down the value of the Martian mean annual temperature to 47.7° F. (8.7° C.). An interesting side issue on this matter leads Professor Lowell to state that the special brilliance of Venus as compared with the other planets is to be ascribed to the presence of a dense air envelope, from which sunlight is directly reflected. This conclusion is also in agreement with the prolongation of the terminator of the planet as it passes inferior conjunction before the sun.

Reverting to Mars, it is found that five-eighths of the surface is desert, and the mean surface albedo comes to be 0.10, and as the total albedo is 0.27, the albedo of the air envelope will be 0.17.

The air density at the surface is given as 2.5 inches, which would give 111° F. (44° C.) for the boiling point of water. As sublimation will take place more freely on Mars at a given temperature there will be proportionately more water vapour in the air there.—*Proc. American Academy of Arts and Sciences*, Vol. XLII., p. 651, March, 1907.

### Systematic Search for New Variable Stars.

An additional research is now being prosecuted at the Harvard College Observatory, with the object of determining the distribution of variable stars in various regions of the sky. The method is a photographic one, and consists of superposing negatives of a certain region on a contact print taken from a second negative of the same region, obtained at a different time. In the instances described, five negatives of each region were employed, four of which were compared with prints from the remaining one. The stars showing signs of change are marked, and on subsequent reduction, some of these may prove to be known variables, some to be new variables, some are still suspected of variability, and some may be due to photographic defects. From the number of actual new variables found by super-

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posing plates of the same region, an estimate may then be made of the number still undiscovered. In the trials so far made the results appear so promising that it seems best to cover the whole sky by the method as soon as possible, and thus provide for determining the probable distribution, and later the work can be confirmed and extended by means of photographs with a larger instrument. As the result of this preliminary count, it appears that the greater proportion of existing variables have been detected, and of those still undiscovered it is probable that all are faint, none being estimated as brighter than the eighth magnitude, or having a range of variation of more than a magnitude.—*Harvard College Observatory Circular*, p. 127.

### Jupiter Apparently Moonless.

Taking account solely of the four largest satellites of Jupiter, which are still the only ones which can be observed with moderate sized instruments, there will be an interesting configuration of the system during the coming autumn, on October 3, 1907. On this day, all four satellites will be on or very near the line of sight from the Earth to Jupiter, and at all places where the planet is above the horizon at the time there will be presented the unusual spectacle of a moonless Jove. Unfortunately, the inhabitants of the Western World will not be able to participate in this scrutiny as Jupiter does not rise at Greenwich until midnight. Observers in Asia and Australia should, however, be in the position of noting the phenomenon, and the following particulars may be useful to those fortunate enough to do so.

| Satellite. | h. m. s. | | h. m. s. |
|---|---|---|---|
| I. Eclipse Disappearance .. | 6 13 45 | Occultation Reappearance | 9 39 0 |
| II. Transit Ingress .. .. | 7 46 0 | Transit Egress .. .. | 10 43 0 |
| III. Eclipse Disappearance .. | 4 30 27 | Eclipse Reappearance .. | 7 56 26 |
| IV. Occultation Disappearance | 4 17 0 | Occultation Reappearance | 8 52 0 |

It will thus be seen that from 7h. 46m. to 7h. 56m. all four satellites will be invisible from the Earth, I., III., and IV. passing behind the planet, while II. is passing in front of the disc.—*Revue Generale*, May 15, 1907, p. 342.

### Kodaikanal Observatory Report, 1906.

In spite of the fact that, as the Director remarks, the weather in the South of India during 1906 was unusually bad, we have evidence from the results given in the report that the station is capable of furnishing the various data concerning the solar activity for the greater part of even an unfavourable year.

The spectroheliograph was in constant use during the greater part of the year; the work had to be discontinued on December 17 on account of the dismounting of the siderostat for alterations in the building. On 26 days no observations of the sun were possible. Photographs of the sun's disc in calcium light were taken on 277 days, as against 317 in 1905, but part of this difference was due to the stoppage mentioned above. An important statement is made with regard to the taking of spectroheliograms on days when the weather is unfavourable, as it appears that surprisingly good plates are sometimes secured through clouds so thick as to necessitate six or eight times the exposure given with a clear sky. In general the photographs of prominences appear to be better than those of flocculi when the sky is clear, but good flocculi plates are often obtained when the glare from thin cirrus clouds is strong enough to seriously interfere with prominence photography. It is only possible to get the necessary steady solar images during a few hours in the early morning.

Photograph's of the sun's disc to a diameter of about eight inches were made with the Dallmeyer photoheliograph on 317 days, and negatives have been forwarded to Greenwich to fill in the gaps of the series for measurement.

Observations of sun-spot spectra were made with an Evershed three-prism spectroscope on 181 days, but on 14 of these the work was not completed on account of bad weather. The work includes the recording of the most prominent widened lines and a careful examination of the behaviour of the hydrogen and helium lines in the neighbourhood of all spots.

Prominences were recorded on 269 days, 53 being incomplete. The visual record in hydrogen light is afterwards compared with the prominences recorded by the spectroheliograph in calcium light.

The staff has now been increased by the appointment of Mr. J. Evershed, as Assistant Director, who reached Kodaikanal in January of this year.

### "The American Astronomer."

We have received the first number of a new publication with the above title, which is intended to appeal primarily to practical astronomers. At first it was intended to issue the paper as a weekly, but this was altered to a monthly issue. The current number is devoted to interesting items of news from the various observatories, discussions of various problems, and reviews of current treatises on astronomical research.

## BOTANICAL.

By G. MASSEE.

### Contagious Chlorosis.

THE term chlorosis has been used to express the gradual disappearance of the green colouring matter or chlorophyll from leaves, young shoots, etc. In some instances this loss of green colour extends over the entire surface of the leaf, in others only patches or streaks are destitute of green, giving the leaf a variegated appearance. The cause of this variegation is unknown; it is hereditary in many varieties of plants.

Dr. E. Baur has recently described, in *Ber. d. deutsch. Bot. Gesellschaft*, a form of variegation, which he calls infectious chlorosis, differing from ordinary chlorosis in its power of imparting, through a supposed virus, its peculiarity to another allied plant. This peculiar form of chlorosis exists in certain members of the mallow family, in privet, laburnum, and is in all probability of widespread occurrence. The cultivated variegated mallows were derived from a form of *Abutilon striatum*, called *A. Thomsoni*. This plant transmits its variegated condition by grafting. Baur observed that if the leaves are removed, and the plant is kept in the dark, the new shoots produce only very few variegated leaves, and if those are removed the plant remains permanently green in the light, unless it is again infected by grafting scions of a variegated plant. If latent axillary buds of the old portions of a plant treated as above produce variegated leaves, the whole plant quickly becomes infected. When scions of the immune *A. arboreum* are grafted on the infected *A. Thomsoni*, they grow readily, but do not become infected, whereas if scions of a susceptible kind are in turn grafted on the piece of *A. arboreum* of the previous experiment, they become infected, thus proving that the virus can travel unchanged through the intermediate piece of *A. arboreum*; shoots bearing green leaves that are immune to the disease sometimes appear on *A. Thomsoni*. If one of these shoots is grafted on a variegated plant, the scion continues to produce green leaves. If, in turn, a susceptible scion is grafted on to the immune branch, its leaves are variegated, proving that the virus passed through the immune branch. This passing of the virus unaffected through a portion of an immune branch does not always hold good. If a scion of *Lavatera arborea* is grafted on *A. Thomsoni*, and another susceptible portion is in turn grafted on the *L. arborea* portion, the leaves do not become variegated, showing that the virus loses its potency in passing into the immune scion of *L. arborea*.

The author considers that this form of variegation or chlorosis is due to the presence of a virus, depending on light for its production. When grown in the shade, susceptible plants lose the variegation and become green. Experiments proved that the virus travels in the cortex, and not in the wood.

### Electroculture.

Professor Barde, in a paper read before the Agricultural Section of the Society of Arts of Geneva, gives an account of certain experiments demonstrating the efficacy of utilising atmospheric electricity in destroying the phylloxera of the vine, and also in promoting to a remarkable degree the vigorous growth of plants generally. The discovery was first made by a cultivator of vines. The method consisted in the arrangement of two series of metallic conductors traversing the roots at a depth of about sixty centimetres, so as not to injure the above-ground portion of the vines.

Each series of conductors forms with the plants it traverses an electrode, and electric currents are liberated by neighbouring electrodes of contrary signs. One of the collectors is bound to a lightning rod, about twenty metres in height, furnished at its extremity with a quantity of small copper points. The other is attached to a metal plate, buried in the ground. The experiment was tried on vines badly infested with phylloxera, and at the end of the first season it was found that most of the insects were killed, and at the end of the second season not a single living insect could be discovered. In addition to destroying the phylloxera, it was observed that the treated vines grew much more vigorously than a check batch of untreated ones, the quantity and quality of the fruit was also much better in the treated batch.

This primitive method of applying electricity has been modified by Professor Barde, who finds that in place of a current of about 120 volts, as first used, currents varying between 1,000 and 2,000, or even 3,000 volts can be applied without producing the slightest injury to the plants treated.

The paper closes with the announcement that this discovery has been patented in various countries, and that all rights are vested in the Société suisse d' Electroculture.

### Water-Storage Organs of Desert Plants.

The adaptations of plants growing in arid regions, for accumulating and holding a reserve supply of water, have been described by Dr. MacDougal, in the "Fifth Year Book of the Carnegie Institution of Washington."

Special storage organs and storage plants are most abundant in regions in which the scanty rainfall occurs during a brief period only, while during the remainder of the year precipitation is comparatively lacking. The development of tissues for storage purposes is varied, and shows some important morphological features. *Ibervillea sonoræ*, one of the cucumber family, produces a storage organ the size of a squash, at the base of the stem, which is covered with a skin highly resistant to evaporation. During the dry season these structures lie unchanged on the hot sand. At the commencement of the rainy season, roots and shoots are quickly formed, and fruit and seed matured, when the thin stems die down and the organ rests for another season.

Some of these storage organs were collected and placed on a dry shelf in a museum, in 1902, where they have since remained. Every year since, at a period corresponding to the rainy season in its native habitat, thin stems are produced, which eventually die back. Five years' growth has already been made at the expense of water stored up in 1901, and the storage organs are still sound and will probably furnish supplies for the annual production of stems and leaves for some years to come.

### Influence of Fertilization on the Quality of Figs.

M. Leclerc du Sablou points out (*Comptes Rendus*) that in France certain varieties of figs are cultivated, the ovules of which are not fertilized, and consequently become aborted, hence the hard, gritty "seeds" present in ripe figs where the ovules have been fertilized, as in Italian varieties, are absent.

Figs, where no fertilization has occurred, contain a larger amount of sugar, and are perhaps equally good from every other standpoint when eaten fresh, as figs where the ovules have been fertilized. In the dried condition, however, the latter are decidedly superior, the pleasant taste and perfume being due to the reserve material in the form of oils present in the "seeds." In addition, when the ovules are fertilized the fig usually weighs more than in the case of unfertilized figs, consequently, a much heavier crop is secured.

## CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

### A Case of Soil Electrolysis.

A CURIOUS effect of leakage from the negative cable of an electric tramway in Liverpool has been investigated by Dr. Bassett. The leakage was discovered through horses receiving shocks when passing over the place, and when the ground was opened it was found that the top of the wooden trough carrying the cable had been burned through, while a hard alkaline material had penetrated the hole and become so firmly incrusted on the wire that it had to be chipped off with a hammer and cold chisel. The fragments were of a dark grey colour, and on treatment with water, emitted bubbles of hydrogen, which caught fire and burned with a lavender or yellow flame. This reaction pointed to the presence of free potassium or sodium, and, in fact, when the material was broken open, the interior crevices were found to contain a fluid alloy of the two metals. A quantitative analysis of the incrustation showed it to contain 33.27 per cent. of potassium hydroxide, 32.26 per cent. of sodium hydroxide, 1 per cent. of metallic potassium, 0.8 per cent. of metallic sodium, 4.83 per cent. of soluble silica, 26.36 per cent. of earthy matter, and 1.41 per cent. of moisture and bitumen. Dr. Bassett came to the conclusion that the free alkali metals had first been formed by electrolysis from the potassium and sodium salts in the surface soil, for they were present in the same proportion as in the incrustation; and that the free potassium and sodium then reacted with water to form the respective alkali hydroxides with the evolution of hydrogen. Had there been accumulation of this hydrogen and subsequent admixture with air, a violent explosion might have taken place; and it is not improbable that a chemical process of this kind may account for some of the explosions that have occurred in the neighbourhood of electric mains, the primary cause of which has usually been attributed to an accumulation of escaping coal gas.

### Calcium Chloride as a Dust Preventer.

The first experiments in "watering" roads with a solution of calcium chloride were made in 1828, in France; but although successful as a means of preventing dust, the process seems to have been abandoned until 1859, when dilute hydrochloric acid was tried in Lyons, with the object of converting the lime in the dust into calcium chloride. This treatment was also a success, but was not continued, probably on account of the expense. In 1873, however, a solution of calcium chloride began to be used regularly in place of water, for the streets of Rouen, and the treatment was continued for several years. The advantages of using this salt are, that it attracts moisture from the air, and thus remains damp, and that it has a disinfecting power said to equal that of a solution of tar. It has been shown by M. Houzeau, that the use of a solution of calcium chloride is 30 per cent. more economical than ordinary watering, since the residue of salt, being deliquescent, remains moist for six days upon the road. Magnesium chloride has now taken the place of calcium chloride in Rouen, since it is claimed to have a greater disinfectant power, and to render wood pavement fire-proof; but in the opinion of MM. Houzeau and Le Roy, calcium chloride is the better material. It is cheaper than tar or oil, and, unlike them, does not form a disagreeable mud after a thaw. It is also readily procurable, since it is a bye-product in numerous industries, such as the manufacture of mineral water, in which the carbon dioxide required for aëration may be obtained by the action of hydrochloric acid on chalk.

### The Synthesis of Protein.

Mr. A. E. Taylor's successful experiments on the synthesis of protein, an account of which is given in a recent issue of the "Publications of the University of California," are of the greatest interest to the chemist and the biologist. Attention has frequently been called in these columns to the chemical changes brought about through the agency of ferments, or enzymes, as they are now more suitably termed. For instance, starch is acted upon by water in the presence of the *diastase* of the saliva or of malted barley, yielding simpler products (maltose, dextrins, etc.); whilst white of egg, which may be taken as a typical protein, is transformed into simpler products (peptones, amino-acids, etc.), through the agency of the *pepsin* of the stomach and *trypsin* of the pancreas. These reactions can also be brought about outside the body by digesting the substances with water, at a suitable temperature and in the presence of minute quantities of the enzymes. Now it has been found that if the action of certain enzymes be allowed to continue after the breaking down (hydrolysis) of the original

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substance has proceeded as far as it will, a reversed action may take place under suitable conditions, and the products be very gradually condensed again to form the original product. This has been established in the case of the enzymes that act upon starch and fat, but hitherto all attempts to effect a similar synthesis of proteins have been fruitless. Mr. Taylor, attributing these failures mainly to the insufficient stability of the enzyme preparations employed, made experiments with trypsin from different sources, and found that that contained in the liver of the large soft shelled clam did not lose its activity during a long period. The protein used in the experiments was protamine sulphate, obtained from the spermatozoa of the striped bass; it was chosen as being one of the simplest bodies of the kind, and yielding but few products on treatment with trypsin. The digestion was first carried on in a flask, as far as it would go, and the solution of the products (mainly compound ammonias) sealed up in another flask with a glycerine extract of the liver of the clam. The contents of the flask gradually became turbid, and finally, after some months, there collected at the bottom a white deposit which was found to correspond in composition and properties with the original protein. This is the first experimental proof of the commonly accepted theory that the formation of proteins in plants and in the absorption of the products of digestion in animals are both processes of condensation, brought about by the influence of enzymes, which are themselves unaffected in the reaction.

## GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

### Pseudomorphous Pebbles of Pyrites.

IN the Main Reef of the Reitfontein Mine of the Witwatersrand are scattered numerous rounded pebbles of pyrites, which are believed by Mr. C. B. Harwood to be pseudomorphs. They occur in what is known in consequence as the Buckshot Reef.

They exhibit radiate fibrous structure, and are probably of concretionary origin. At the Crown Reef Mine a few "pebbles" of pyrites, some as much as an inch in length, occur in a narrow band of conglomerate at the contact of the reef with a basic dyke, but in this mine many of the "pebbles" are of calcite, and were believed by Mr. J. Huntz to be due to the replacement of quartz by calcite. In the case of the pyrites pebbles, it is conjectured that the mineralising solutions which deposited the pyrites (together with some if not all of the associated gold) ascended along the fractures due to the intrusion of the dyke, and found an easy course along the small conglomerate-bed, where they replaced some of the quartz pebbles with pyrites, being kept up by a band of shale underneath the conglomerate.

An important paper has been brought before the Geological Society by the Rev. Prof. G. Henslow, M.A., F.G.S., on the Xerophytic Character of Coal-Plants, and a Suggested Origin of Coal-beds.

Of the Palæozoic flora, the *Equisetites*, represented to-day by the sole genus *Equisetum*, are decidedly hygrophytic, if not hydrophytic. The Ferns, which appear to have much resemblance to certain modern types, especially the *Marattieæ*, seem to have lived under more or less similar conditions to the present; *i.e.*, varying from the hygrophytic habit of *Hymenophyllum* to the xerophytic *Ceterach*. The *Cycadofilices*, *Cordaites*, etc., are decidedly xerophytic; and the same is the character of the *Lycopodes*, represented now by *Lycopodium* and *Selaginella*, and of *Psilotium*, *Salisburia*, and others. In fact, the characteristic feature of the great coal-forests was xerophytic, and the vegetation appears to be of an upland type. Illustrations were given from modern and Carboniferous plants to show the characters of leaf, root, and stem which separate these classes of plants. The position of coal-seams is accounted for by the action of earth-movement in late Carboniferous times, which threw the forest-bearing surface into shallow waves and troughs, which became gradually accentuated, the latter being gradually filled with sediment, on which, during intervals of rest, new forest-growth took place.

### Women and the Geological Society.

The special bye-laws which had been proposed by the Council of the Geological Society, allowing of the admission of women to membership, under the special title of "Associates," at a reduced subscription, were defeated on May 15, by a small majority. The chief opposition to the proposed new bye-laws came from those who declined to support any proposal short of the admission of women to full Fellowship. In the peculiar circumstances of the defeat of the proposals, the movement will presumably take further shape. The centenary year of the Society would no doubt be a fitting year in which to admit female geologists to Fellowship.

## ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

### British Warblers.

THE first part of one of the most complete ornithological monographs which has yet appeared, has just been issued, and we commend it to the notice of the readers of this column, as a unique model of how to observe.

Mr. C. E. Howard, the author of this work, has chosen the British warblers as his theme, and a more difficult group it would have been hard to select. Sober in their colours, and shy and retiring in their habits, but few have ever devoted much attention to their study, and no one has discovered so much that is remarkable concerning them.

The descriptions of the love-displays of these tiny birds contain some most wonderful and surprising facts; which, at first sight, seem almost as though they would destroy the evidence so far collected, on which the theory of sexual selection was founded. But a closer examination of the curious facts that Mr. Howard has brought to light will show that this theory is not seriously threatened.

### The Ear of the Woodcock.

Mr. C. W. Whymper has just brought to my notice a curious point with regard to the position of the ear in the woodcock. The snipe, it may be remembered, are remarkable for the fact that the external ear is placed *under*, instead of *behind*, the eye, as in other birds; but in the woodcock it is placed in *front* of the eye, and more so on one side of the head than on the other. This asymmetry, furthermore, extends to the shape of the aperture, which is slightly different on the two sides of the head.

Mr. Whymper has placed specimens in my hands for dissection, and I propose to deal with the subject at length at no distant date. It is strange that this fact has not been noticed before. A brief description of the way the discovery was made appears in the June number of *British Birds*, from the pen of Mr. Whymper himself.

### The Migration of Birds.

The British Ornithologists' Club has just issued their "Report on the Immigration of Summer Residents in the Spring of 1906." It should certainly be diligently studied by all who are interested in this most mysterious instinct.

From a brief perusal of its pages we gather that the migration season of 1906 was noticeable for the prolonged period during which many of the species arrived. The earlier part of April showed the arrival in numbers of exceedingly few species, but this condition of affairs was altered on the 18th of the month, when an immense immigration of birds of all kinds commenced. From that date to the end of the first week in May, immigrants continued to pour into these islands.

### Food of Early Cuckoos.

We have often wondered what the first arrivals of the cuckoos could find to feed upon. This question has now been settled by Mr. F. W. Frohawke, who, in the *Field* (May 4), writes to say that this food is furnished by the larvæ of the tiger-moth, which, by the time the cuckoo reaches us have already attained to some size, quite sufficient to sustain even the appetite of this rapacious bird.

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### The Dotterel at Athlone.

Mr. W. J. Williams, in the *Irish Naturalist* for May, records the fact that three specimens of the dotterel (*Endromias morinellus*) were shot at Athlone, on the 10th November, last. All were females, two showing the white band on the breast. This species is exceedingly rare in Ireland.

## PHYSICAL.

By ALFRED W. PORTER, B.Sc.

### Rays of Positive Electricity.

IN the *Philosophical Magazine*, Professor J. J. Thomson describes the results of a series of experiments on the streams in a vacuum tube, which have hitherto been known as *Kanalstrahlen*, but which he prefers to call *rays of positive electricity*. These are the coloured brushes of light which proceed backwards (that is, in the direction opposite to that of the cathode stream) from a pierced cathode; the colour depends on the gas with which the tube is filled and coincides with the colour of the velvety glow which occurs immediately in front of the cathode. They were discovered by Goldstein; Wien showed that they could be deflected by a magnet, and that they were deflected in the opposite sense to that in which the negative stream would be deflected, thus proving that they consisted of streams of positively charged matter. Since they have been shown to be streams, the present writer would much prefer them to be called so; the term ray should be restricted to wave phenomena. For the same reason the term "cathode rays" arose when these were regarded as a kind of light; but when their true character was recognised, the term cathode streams replaced the original one to a large extent, though it has never completely supplanted it. (Varley, who was their first discoverer, called them *torrents*). The positive streams have been deflected by an electric force also. The value of the ratio of the charge to the mass has been ascertained to be the same as for an atom of hydrogen, as revealed in the electrolysis of solutions. Professor Thomson has very considerably extended Wien's researches, realising that a full examination of these streams would be certain to throw fresh light on the constitution of matter. By submitting them simultaneously to a magnetic and to an electric field, the patch of phosphoresence which they excite when they strike the surface of the tube (dusted over with powdered willemite) is drawn out into bands. When the band is straight it indicates that all the particles in the stream have the same velocity, but different values for the charge per unit mass. When there are two straight bands inclined to one another, there are two characteristic velocities. Now, for helium at moderate vacua, two such bands were obtained, for one of which the maximum value of the charge per unit mass comes out the same as for an atom of hydrogen, while for the second it is about one quarter of this. Since the helium atom has four times the atomic mass of an atom of hydrogen, the second band would seem to be due to charged atoms of helium. Now the alpha particles from radium are usually considered to be atoms of helium; but the value of the charge per unit mass for them is only half that of the hydrogen atom. There is, therefore, a discrepancy here. It is noteworthy that it is only in the case of helium that a second band characteristic of the gas employed was obtained.

With very high vacua, the bands are replaced by patches. These are two in number, whatever the gas with which the tube had been originally filled. One of these has the charge per unit mass of a hydrogen atom, and the other half this value; that is, the second corresponds to an alpha particle, or to a hydrogen *molecule* (*i.e.*, a double atom). The special patch into which the second band of helium first of all changes as the pressure is lowered, disappears altogether at these very low pressures, and the helium now behaves like any other gas. With high vacua, in fact, there seem to be two kinds of carriers for positive electricity, and these carriers are the same, whatever the gas employed.

Although no clear explanation has yet been given of these results, it is obvious that they form a fresh starting point from which additional progress can be made in learning the true constitution of the atom. Negative particles ($\beta$ particles) of very small mass, are ejected from radium, thorium, etc., and forwards from a cathode; positive particles of mass equal to a *molecule* of hydrogen are ejected from radium, and backwards from a cathode; besides these the cathode projects backwards charged carriers, whose mass is the mass of an atom of hydrogen. *None of these differ with change in the substance from which they are obtained.* They all, therefore, are common constituents of many kinds of atoms. More experiment is needed before any definite surmise can be made as to the real constitution of the atom. The idea that it is a congeries of electrons is completely given up. These, and similar questions will be discussed at the Leicester meeting of the British Association, in August next, in which discussion Professor Rutherford and Sir Oliver Lodge have promised to take part. It is hoped that before then sufficient experimental advance will have been made to enable definite conclusions to be reached.

### The Flame Tube.

At the Royal Society's *soirée*, Mr. Ulrich Behn exhibited some interesting and simple experiments with what is called a flame tube. A tin-plate tube not less than 5 cms. diameter, and about one metre long, has two holes bored, one near each end, about 5 cm. diameter. The ends of the tube are corked, and through one cork gas is led and is ignited at the two holes. The flow is adjusted until there is a small luminous tip to the flames, the tube being meanwhile supported in a horizontal position.

The flames are now wonderfully sensitive to small pressure differences in the air outside. If the tube be slightly tilted, the flame at the higher end becomes relatively larger and that at the lower end comparatively smaller. A difference in level of three millimetres can be detected in this way; this corresponds to only two ten-millionths of an atmosphere!

## ZOOLOGICAL.

By R. LYDEKKER.

### The Development of Sea-Urchins.

WE have been favoured with a copy of a paper by Mr. J. Loeb, from the Physiology Series of Publications of the University of California (Vol. III., p. 57), recording the results of a recent investigation into the mode of fertilisation of the eggs of sea-urchins. As these results are of a most remarkable nature, it will be advisable to quote the author's own words. "Certain theoretical considerations," it is stated, "made it appear probable that those substances which cause the development of the egg must be found in liquids or cells of the body other than the sperm. A search in this direction revealed the fact that the blood-serum of certain Gephyrean worms (*Dendrostoma* and *Sipunculus*) contains a substance which causes the membrane-formation and starts the development in the unfertilised egg of the sea-urchin. . . . The experiments indicate that the active substance of the serum of *Dendrostoma* is neither a fatty acid nor a hydrocarbon. It may be a protein, inasmuch as the efficiency of the serum is annihilated by heating it for a couple of minutes to the boiling point."

### A Lost Cetacean.

A second paper, of which we have received a copy, is one by F. W. True on a fossil whale's skull from the Eocene Tertiary beds of the Ashley River, South Carolina, published in the quarto series of the Smithsonian Institution, Washington. The skull, which was discovered so long ago as 1847, and now seems to be lost, indicates one of the primitive dolphin-like whales of the squalodont group, so named on account of their somewhat shark-like teeth. It was made the type of a genus by Cope, in 1895, and is now known as *Agorophius pygmæus*.

### Local Races of the African Elephant.

At the meeting of the Zoological Society, held on April 23, the writer of these notes read a paper on local variation in the African elephant, chiefly as exemplified by differences in the relative size and the shape of the ear; this being the part most readily available for comparison. Even allowing for variation in size and shape due to the

manner in which the specimens had been dried or mounted, it was shown that enormous differences existed in these respects in the ears of elephants from different parts of Africa. Thus, for instance, while in the gigantic elephant of the Blue Nile, the ears are as much as six feet in maximum diameter, in its smaller relative from Somaliland, they are less than half this extent. The elephant of the Congo, again, has ears differing altogether in contour from those of the one inhabiting the Aberdare Mountains of British East Africa; and it was concluded that several races in addition to those already named by Professor Matschie, of Berlin, might be recognised. Special attention was directed to the skull of an elephant from the Albert Nyanza district, which appeared to present a closer resemblance to that of an extinct Indian species than to any other African specimens which had been examined. The author was indebted to the Duc d'Orléans, the Duke of Westminster, Sir E. G. Loder, Mr. F. C. Selous, Major Powell Cotton, Mr. A. Haig, and other gentlemen, for the loan of specimens and photographs.

### The Antarctic Fauna.

Expert study of the zoological collections of the *Scotia*, continues to furnish important additions to our knowledge of the Antarctic fauna. One of the most interesting "finds" was the tiny marine fish known as *Prymnothonus hookeri*, of which the type, and hitherto only definitely authenticated specimen, was discovered during the voyage of the *Erebus* and *Terror*. Scarcely less interesting are certain features relating to the distribution of birds, recorded by Mr. Eagle Clarke; but the consideration of these must be left to my friend, Mr. Pycraft, since, according to the classification adopted in "KNOWLEDGE AND SCIENTIFIC NEWS," ornithology is a science apart from zoology.

### Newspaper Natural History.

The writer of "Echoes of Science" in the *Globe* is frequently a fertile source of amusement to me, and he was more than usually so in the issue of that excellent newspaper for April 26, when he seems to have honoured me by compiling at least four of his paragraphs from notes communicated by myself to various journals, without revealing the source of his information. At any rate, I infer this to be the case, and for the following reasons: Firstly, because these paragraphs refer to subjects upon which I have recently had occasion to comment, and that the papers on which three of them are based are not likely to come in the way of a writer of his capacity. Secondly, because he unwittingly repeats a misrepresentation made by myself. Lest, however, the readers of "KNOWLEDGE AND SCIENTIFIC NEWS" should be led to imagine that all the egregious blunders made by this learned gentleman are due to me, I hasten to mention that I never asserted that "the moa" and "the nearly extinct Notornis," are now living in the bird sanctuary on Revolution Island, New Zealand! I am looking forward to further amusement from the same entertaining, if not exactly accurate, writer.

### Papers Read.

A collection of fishes from the Transvaal formed the subject of a paper by Mr. Boulenger read at the meeting of the Zoological Society, held on April 9, when Mr. Pycraft discussed the osteology of certain perching birds, while Mr. Beddard described the anatomy of a frog from Borneo. Of more general interest was a communication by Mr. Coward, concerning the habits of horseshoe and other bats inhabiting certain caves in Somerset. Here, at the end of December and beginning of January, the author found that the bats were not in profound sleep, but moved in the caves and went into the open for food. This food was not all taken when the bats were in flight, but usually devoured when they were at rest. The manner of feeding was described and information supplied about the food of the greater horseshoe bat and the parasites infesting both this species and its smaller relative. At the meeting of the same Society a fortnight later, Mr. S. A. Buturlin discussed certain new or little known Siberian birds. Mr. Thomas gave an account of mammals from Saghalien and Hokkaido, with a note on reptiles, etc., by Mr. Boulenger, Mr. Sherren discoursed on hybrid bears, while Mr. Lydekker, as is more fully noted above, gave his views with regard to the number of recognisable local forms of the African elephant.

## CORRESPONDENCE.

### Winter Cold in Relation to the Moon.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Referring to a letter on the above subject in your April number, it would be interesting to ascertain the temperature in the Southern Hemisphere at the time of our winter full moon. Is it there also lower, or as I have heard it popularly maintained, is it warmer at summer full moons and colder in winter generally all over the earth? If so, taking both North and South Hemispheres, the moon would seem to be able to "blow hot and cold" at the same time. Then what about their winter full moon temperature? We ought to find some corresponding change at our midsummer full moon. There must be plenty of material available to settle the question. J. L. J.

### Halley's Comet and Pope Calixtus.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Mr. Crommelin has kindly sent me copies of two letters by Mr. Lynn in *Notes and Queries*, in which he states, "It is evident that the story of a papal bull exorcising the comet is an invention of a later age. I (Mr. Lynn) have examined the collection of bulls . . . only four issued by Calixtus III., relating to the mendicant and other religious orders, and find no mention whatever of a comet. When the story was first invented it is difficult to say." A very definite statement with regard to the issue of a papal bull and an order for the ringing of bells at mid-day is, nevertheless, to be found in Lardner's *Astronomy*, Vol. II., p. 542. Young, in his *General Astronomy*, states the excommunication as a matter of popular belief, but says, further, "It is doubtful, however, whether such a formal bull was ever really promulgated." F. W. HENKEL.

### Answers to Correspondents.

*John H. Bowers* (*Hartford, Conn.*).—To cement celluloid to celluloid use a solution of celluloid in amyl acetate. I know of no very satisfactory cement to make a surface of celluloid adhere to glass, if that is what is required, but a layer of the celluloid solution adheres very well, and of course can be built up to practically any required thickness by repeated applications. It is a little dangerous to use celluloid in electric machines because of its great inflammability, but the layer formed by coating glass (which should first be coated with shellac) is perfectly safe and is practically non-inflammable. Ebonite may also be coated in the same way.

*Commander Squire.*—The Solar System is moving towards the star $\lambda$ in the constellation of Hercules. Herschel first noted that the stars Arcturus and Vega (on either side of Hercules) were receding from one another, while Sirius and Aldebaran were approaching one another, proving that the Solar System was moving towards Hercules. Ball gives the rate of progress as 10,000 miles every half-hour, and says it would take far more than a million years to traverse the distance.

NEW SECTIONAL PAD.—We have received from Messrs. W. and A. K. Johnston, a new form of sectional pad which has several features to recommend it to those engaged in astronomical, mathematical, or meteorological calculations. The squares into which the sheets are plotted are on the scale of one inch to the mile, and the linear dimension of each square represents one hundred yards. This subdivision increases the usefulness of the sheets for engineering, surveying, and map drawing purposes.

# REVIEWS OF BOOKS.

## ANTHROPOLOGY.

**The Native Races of the British Empire; the Natives of British Central Africa,** by A. Werner (London: Constable, 1906; pp. xii. and 303, illustrated; price 6s. net).—It is highly satisfactory to find that this important series of work is being pushed on with all possible rapidity, and we tender a hearty welcome to this, the second, volume. The author, although he quotes largely from Sir H. H. Johnston's well-known work, appears to have a thorough personal knowledge of the country and its people, so that his statements may be taken as being first-hand information. Without, we hope, laying ourselves open to the charge of captiousness, we venture to think that the work would have been better if a portion of the chapter devoted to the characters and natural history of the country had been omitted, and the space thus gained utilised for fuller details concerning the physical characteristics of the natives, accompanied by full-face and profile portraits of a certain number of selected types. Even when physical characteristics are mentioned we find a lack of precision and detail, as is exemplified on page 32, where the author observes: "I should have said . . . . . that a good proportion of them were six feet or over." This is not at all the kind of information we have a right to expect in a work of this nature, and it is to be hoped that there will be an improvement in such matters, as well as with regard to anthropological photographs, in the succeeding volumes of the series. The volume deals, however, mainly with native customs, myths, and manners; and from this point of view will be found of great value. All the negro tribes inhabiting the Protectorate belong to the great Bantu branch; among them being the tall and powerful Yaos, and the Angoni, who are comparatively recent immigrants of Zulu origin. The following is one of the strangest and most special of Bantu legends. The chameleon and the lizard were severally commissioned to take a message to mankind; the former to say that although men must die, yet they would return again, the latter that death was the end of all things. Despite an earlier start, the chameleon was outstripped by the lizard, who delivered his message of death. When the chameleon arrived and gave his message, he was told that it was too late, and that the first mandate had been accepted. To this day the members of the Anyanja tribe put a morsel of snuff into the mouth of every chameleon they meet, in order that it may die. One section of the tribe holds, however, that the snuff, despite its fatal effect, is given as a reward to the reptile for its message.

## CHEMISTRY.

**A Text Book of Organic Chemistry.** English Translation, from the German of A. Bernthsen, Ph.D. Edited and Revised to date. By J. J. Sudborough, Ph.D., D.Sc., F.I.C. (London: Blackie; pp. xvi. and 658).—The chemistry of the carbon compounds has grown to such an extent that it is quite impossible for any one mind to keep in touch with the new substances that are discovered daily, even if there were any advantage, beyond training the memory, in trying to do so. The most that can be expected of anyone is to have a practical knowledge of typical compounds in each class, and of their modes of preparation and relationships to one another. In short, a general survey is what should be aimed at in a general text-book, and the student of any special branch of the science should be left to supplement his knowledge from special text-books. This idea has been admirably carried out by the English editor of Bernthsen's well-known work, and the reader gains greatly by the way in which the general principles of chemistry as a whole are steadily kept before him. The plan of the work is the same as in previous editions, but many of the chapters have been thoroughly revised, and the book concludes with new chapters dealing with the stereo-chemistry of certain compounds, and with the relationships between physical properties and chemical constitution. The book is clearly printed, and has a good index, and we can thoroughly recommend it from every point of view.

## EVOLUTION.

**The Evolution of Life,** by H. Charlton Bastian (London: Methuen and Co., 1907; pp. xviii. and 319, illustrated; price 7s. 6d. net.).—Since this is essentially a controversial work, written by one who, so far as his opinions on this particular subject are concerned, "hath not honour in his own land," it behoves a reviewer to be circumspect. Indeed, it will be safer to refrain from offering any opinion of our own, and merely refer to the author's views as expressed by himself. The object, then, of the present volume is to make known the experiments which, in Dr. Bastian's opinion, demonstrate the existence of spontaneous generation, or archebiosis, as a factor—and a most important one—in the evolution of life. In the preface the hope is expressed that he has "done something at last which will carry conviction to very many as to the reality of the present *de novo* origin of living matter. The penultimate chapters . . . . will show that in my new attempt to solve this old and fascinating problem, the experiments have in some respects been conducted in a new way, though by methods as notable for their simplicity as for their stringency in reference to all possible precautions." With these words we leave the matter in the hands of our readers, trusting that they will not be slow to study the book themselves and form their own judgments as to whether the author has proved his case in what is really a very important issue.

## ORNITHOLOGY.

**British Birds' Nests,** by Richard Kearton, F.Z.S. (London: Cassell and Co.; 1907, 21s.).—This is really a new book under an old title, for twelve years ago Mr. Kearton published what was then a really remarkable volume on the subject of birds' eggs and nests, and it has held the field against all comers till to-day, when it appears again, Phœnix-like, in the form of a second edition. But the present is a far more portly volume, and far more profusely illustrated. While in so many volumes, where the illustrations are many, not a few are but indifferent specimens of their kind. This is not the case with Mr. Kearton's book, wherein every picture is of its kind good—excellent, in fact. There are, besides, several photogravures among these illustrations, and they are singularly beautiful examples of the photographer's art. The most striking feature of this new volume is, however, a number of coloured plates of eggs, which are really extremely well and faithfully reproduced. As in the previous volume, Mr. Kearton has described his species in alphabetical order, and this, for his purpose, was probably the best possible arrangement. As Mr. Kearton writes about birds from a first-hand knowledge, it was not to be expected that we should catch him tripping—it would not pay to attempt such a feat. But we might remark that he omits to point out the distinguishing mark of the female nightjar, while, by some slip, the key to Plate 5 has gone wrong, so that the pied fly-catcher egg is attributed to the swallow and *vice versa*, while the names indicating the eggs of the edge-sparrow and spotted fly-catcher have similarly got transposed. But a reference to the text would set the reader right. This is a book the purchase of which no ornithologist can long withstand, even though its price is one guinea.

W. P. PYCRAFT.

# CATALOGUES.

SCIENTIFIC APPARATUS.—Mr. C. Baker has sent us a copy of the April issue of his list of second-hand scientific instruments, embracing over a thousand articles, classified in a manner which enables any particular piece of apparatus to be readily found.

NATURAL HISTORY SPECIMENS.—From Mr. Robert Brogden, we have received two lists, covering respectively zootomical preparations, illustrating comparative anatomy, and zoological material for museums and nature-study classes. Mr. Brogden devotes himself to the supply of biological material of all kinds, including rare and interesting species which he is able to obtain from his correspondents abroad. His list should be in the hands of museum curators and teachers.

XUM

# MICROSCOPY

*Conducted by* F. SHILLINGTON SCALES, B.A., F.R.M.S.

## The Preparation of Microscopical Objects.

(*Continued from page* 118.)

LET us take *glycerine* first. Glycerine is seldom used pure, but generally with a certain amount of water. Its great drawback is its property of absorbing water, and its solvent action upon the various cements which are used to ring round the preparation and to enclose it in an airtight cell. Its other great drawback lies in the fact that it will not dry or harden. The result is that glycerine mounts can scarcely be said to be permanent, and are a constant source of trouble to the owner of a cabinet, and slides made up with this medium require constant watching, and sometimes re-ringing. A further point to be noticed is that glycerine acts as a solvent on calcareous substances.

In favour of glycerine may be mentioned its convenience, its ready applicability to many objects, with a minimum of preparation, and its refractive index, which makes it of good differentiating power.

Glycerine, as an aqueous medium, requires objects to be transferred into it direct from water, being thus in striking contrast to Canada balsam. The glycerine may be used pure, or diluted with water, the former having the higher refractive index, and thus giving the greatest differentiation. *Glycerine, alcohol, and water* also make a useful mounting medium for delicate objects, in the following proportions:—

| | |
|---|---|
| Glycerine ... ... ... | 1 oz. |
| Alcohol ... ... ... | 1 oz. |
| Water ... ... ... | 2 ozs. |

*Farrant's solution* is a mixture of glycerine, water, and gum, and is more convenient than ordinary glycerine, as it sets at the edges. It may be made up as follows:—

| | |
|---|---|
| Gum arabic ... ... ... | 2 ozs. |
| Glycerine ... ... ... | 2 ozs. |
| Water ... ... ... ... | 1 oz. |

(To be kept in a stoppered bottle with a lump of camphor or some crystals of carbolic acid.)

*Glycerine jelly* is semi-solid when cool, and requires to be melted before use, either by putting the bottle in a cup of hot water, or by heating the slide on a hot mounting plate, and putting a suitable piece of the jelly on it, as required. The glycerine jelly sets very rapidly as the slide cools. The following is a good formula, though it will be safest for most workers to buy it ready made at the opticians.

| | |
|---|---|
| Water ... ... ... ... | 3 ozs. |
| Glycerine ... ... ... | 3½ ozs. |
| Gelatine ... ... ... | ½ oz. |
| Carbolic acid ... ... ... | 1 drm. |

(Dissolve the gelatine in the water, and add the glycerine and carbolic acid. Warm for a quarter of an hour, stirring well, and taking care that the temperature is not raised higher than 75° C. or the gelatine will become changed and refuse to harden in use. Filter through fine, hot flannel.)

In mounting in all these media the object must be carefully soaked in water. One of the most troublesome matters concerned with glycerine mounts is their non-absorption of air-bubbles, which are often very vexatious. It is, therefore, wise in many cases to soak the objects in water which has been recently boiled, and from which, therefore, the air in solution has been largely expelled, so that it may re-absorb air from the object. In certain cases an air-pump may be used. The object may then be transferred to a solution of water with a little glycerine in it for a further soak, or may be at once mounted in the glycerine medium, either with or without the use of the hot plate. As little pressure as possible should be used when the cover glass is put on, and it is advisable to ring all mounts with a ring of glycerine jelly, and to cover this with a ring or two of gold size, Ward's or Bell's cement, or marine glue, though I confess to having no love for the latter. Any excess of glycerine can be removed with water and a brush, and it is necessary to make sure that the edges which the cement overlaps are quite free from glycerine, or the former will not adhere properly.

(*To be continued.*)

## Royal Microscopical Society.

April 17.—J. C. Karop, Esq., in the chair. Mr. J. E. Barnard exhibited and described an adaptation of the mercury vapour electric lamp for use with the microscope, by means of which three bright lines in the spectrum were obtained. Mr. Barnard was endeavouring to screen off two of these lines so as to obtain pure monochromatic light, but though hopeful of success, he had not yet been able to obtain a suitable screen. With this light, specimens might be stained very faintly. Mr. F. W. Watson Baker exhibited an expanding stop for use with a sub-stage condenser so that a dark ground with annular illumination could be obtained with objectives of different apertures. Mr. A. Earland exhibited a number of slides of Arenaceous Foraminifera arranged in a series to show the varying skill and selective power exercised by such lowly organisms in construction of their testa or shells. Dr. Hebb read a paper by Mr. E. M. Nelson on "The Podura Scale," in which the author traced the efforts of previous observers to interpret the markings on the scales, giving figures—which were drawn to an enlarged size upon the board—to illustrate the various interpretations, including the result of his own observations. Mr. Conrady and Mr. Gordon took part in the subsequent discussion. An abstract of a paper by Dr. Antonio Rodella on "The Root Bacteria of Pulse" was read by Dr. Hebb. Dr. Ettles described the Ettles-Curtis ophthalmometer and a Corneal microscope devised for measuring the curvature of the cornea by means of light reflected from it. Light from electric lamps impinged upon the eye and the radius of curvature in two directions was ascertained by the angle of reflection observed, thus determining the amount of astigmatism, if any. A demonstration was given upon a patient with pronounced astigmatic vision, who presented himself for the purpose.

## Quekett Microscopical Club.

April 19.—As introduction to a paper which followed, Mr. D. J. Scourfield, F.Z.S., F.R.M.S., said a few words in general description of the group Rhizopoda. The chief works on the subject were mentioned, and the classification adopted was described. The group is the lowest of the four main divisions of the Protozoa, and the term Rhizopoda now includes only those forms which have lobe-like or filiform pseudopodia. Three groups are recognised, divided according to the nature of the pseudopodia—Lobosa, Filosa, and Reticulosa.

Some 60 genera and about 250 species are admitted by recent authorities. Mr. Scourfield then read a paper communicated by Dr. Eugéne Penard, of Geneva, describing the methods he had adopted for the collection and preservation of specimens from this group. Material is chiefly obtained from the organic "felt" which usually covers the mud of the bottom of ponds, streams, and marshes. The gatherings are passed through a sieve with a ½ mm. mesh, which permits the passage of the largest Rhizopods, but keeps back all coarse deposits. A description of the author's methods in collecting from depths of 10 to 40 metres followed, and the paper concluded with a detailed account of the means adopted to isolate, kill, stain, and preserve selected specimens.

### Immersion Oil Bottle.

Messrs. W. Watson and Sons have introduced a new oil-immersion bottle, which, as will be seen from the illustration, is made on the principle of the non-spillable ink-bottle. A movable glass cone fits into the outer

bottle, so that the whole is readily cleaned, the cover is made of box-wood, and attached to this is a wooden rod for transferring the drop of oil. I can speak from personal experience of the cleanliness, freedom from dust, and convenience of the arrangement.

### Notes and Queries.

*P. W.* (*Colne*).—When you speak of a "spot-lens" I do not know whether you mean a spot suspended on three arms which lies immediately beneath the sub-stage condenser, or the older forms of lens, provided with a spot as part of its integral structure. The principle in both cases is, however, the same. The spot is to shut out central illumination, so that the field of view appears dark. When, however, a suitable object is placed upon the stage the annular rays which pass through the condenser *around* the stop are caught and reflected in all directions by this object, which consequently appears in the field of view most brilliantly illuminated in a dark field. It follows, therefore, that to be efficient, the aperture of the stop must be proportioned to the aperture of the objective. I can give you no rule for this which would be of use to you, but low powers, with correspondingly low apertures, require a stop of small diameter, and high powers a large stop. The condenser is put in focus, which is generally about flush with the stage, and light passed through it by the mirror in the ordinary way, the stop being then placed in position beneath the condenser. The "spot-lens" proper, is used instead of the condenser, and in a similar way. If the back-ground is not sufficiently dark it means that too small a stop is being used; if the whole field and the objects on it are too dark, too large a stop is being used. A little adjustment of the condenser or spot-lens makes a good deal of difference at times. An iris diaphragm *above the objective* enables the best results to be got with all sorts of objectives, and a very few spots. It may be added, that dark-ground illumination becomes less successful as high-power objectives are used, and ⅓ in. or ¼ in. is about the usual limit for good results. The light from a lamp may be reinforced by means of a bull's-eye condenser. It must also be remembered that all objects are not suitable for such illumination.

*W. H. J.* (*Saltburn*).—Insect eggs, when mounted dry nearly always shrivel up, as you say, and they must, therefore, be mounted in liquid. Carbolised water, a weak solution, is suitable, or weak formaline. It is, of course, necessary to close the cell carefully, and this is best done by ringing a cell with gold size or other cement, to fit the cover-glass, so that the latter will not reach quite to the outer edge of the cell. When the first ring is dry a second ring is added on the top, and when this is not quite dry, but just "tacky," the solution is placed in the cell, the eggs arranged in it with a needle, the cover-glass applied, pressed carefully down all round, and several more rings of gold size put over all, to seal the cell safely, each ring being allowed to dry thoroughly before the next is added.

*Ferrum* (*West Hartlepool*).—The preparation of metals for microscopic examination requires much care and some skill, the object being to provide a perfectly flat and smooth surface, which will also readily show the effects of certain reagents. The piece of metal is first filed as smooth and flat as possible; it is then filed again with a very fine file, ane finally finished with graduated emery cloth, stretched on a suitable flat surface, beginning with coarse cloth and finishing with the finest obtainable. During this process it is well to take the file marks as a guide. Finally, the surface must be polished with rouge and water, on a hone made of chamois leather, stretched tightly upon a wooden holder. Various reagents are applied to the surface thus prepared; those most used being iodine, liquorice, and the mineral acids, the time being generally about a few seconds, and the surface being subsequently carefully washed with methylated spirit. The piece of metal is supported for examination in one of the special holders now made by most opticians, and examined by means of reflected light. A half-inch and one-sixth inch objective are the most generally useful.

*J. H. A.* (*Douglas*).—If you want to examine bacteria, I think you must provide yourself with an oil-immersion objective, as they are in some respects the most difficult of all objects. But for ordinary high-power work I think a one-eighth inch dry is as high as it is advisable to go in dry lenses, and even then you will find the working distance very small, and the loss of light such as to require careful adjustment of your condenser and light. I strongly advise you to have nothing to do with a one-fourteenth inch dry lens, or even a one-twelfth inch dry lens—you will find them of very limited usefulness. Watson and Sons make an excellent one-eighth inch of N.A., .88; Leitz one of N.A. .85; Reichert one of N.A. .87, each of which costs 30s., and Swift makes one of no less than N.A. .92, at 50s. I do not think there is much to choose between them.

*New Catalogues.*—W. Watson and Sons, High Holborn, London, send me their new catalogue of microscopic objects, which is, I think, the most complete published, and contains many entries of interest to all workers with the miscroscope. I have also received a new illustrated catalogue from Voigtländer and Sohn, of Brunswick, and of 12, Charterhouse Street, E.C., containing particulars of their microscopes, objectives, and accessory apparatus. Finally, there is a new catalogue from Chas. Baker, of 244, High Holborn, W.C., which is unique in the orderly arrangement of its contents, the completeness of its details of measurements, and in its explanatory notes. Amongst these latter I notice with pleasure that Messrs. Baker decline to lend themselves to statements implying that the ocular rather than the objective varies in magnification with variation in tube length, and not only mark their oculars correctly, but explain how the total magnification is arrived at, and I observe also a very temperate summary of the respective advantages of English and Continental microscopes, which should be read by all purchasers. Amongst new models, there is a very inexpensive non-inclinable microscope, of sound workmanship, for nature study, sold at 25s. The particulars of bacteriological and hæmatological apparatus are very complete, whilst the list of stains is more extensive than I have seen elsewhere.

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.*]

XUM

## The Face of the Sky for June.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.52 and sets at 8.4; on the 30th he rises at 3.48 and sets at 8.18.

Summer commences on the 22nd, when the Sun enters the sign of Cancer at 2 p.m.; this is the longest day, the Sun being $16^h\ 34^m$ above the horizon. The equation of time is negligible on the 15th, hence this is a convenient day for adjusting sundials, as only the correction for longitude is needed. Sunspots and prominences continue to be fairly numerous, though they are usually of the normal type; at the time of writing a large spot is visible to the naked eye in the South-West quadrant of the solar disc.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

| Date. | Axis inclined from N. point. | Centre of disc S. or N. of Sun's Equator. | Heliographic Longitude of Centre of Disc. |
|---|---|---|---|
| May 31 .. | 16° 6′W | 0° 42′S | 319° 26′ |
| June 5 .. | 14° 13′W | 0° 6′S | 253° 16′ |
| ,, 10 .. | 12° 12′W | 0° 30′N | 187° 5′ |
| ,, 15 .. | 10° 6′W | 1° 6′N | 120° 54′ |
| ,, 20 .. | 7° 55′W | 1° 41′N | 54° 43′ |
| ,, 25 .. | 5° 41′W | 2° 16′N | 348° 32′ |
| ,, 30 .. | 3° 25′W | 2° 50′N | 282° 20′ |

THE MOON:—

| Date. | Phases. | H. M. |
|---|---|---|
| June 3 .. | ☾ Last Quarter | 5 20 a.m. |
| ,, 10 .. | ● New Moon | 11 50 p.m. |
| ,, 19 .. | ☽ First Quarter | 2 55 a.m. |
| ,, 25 .. | ○ Full Moon | 9 27 p.m. |
| ,, 12 .. | Apogee | 7 6 p.m. |
| ,, 26 .. | Perigee | 2 18 a.m. |

OCCULTATIONS.—The star ξ Ophiuchi, magnitude 4·5, is the only naked eye star occulted before midnight during the month. The occultation takes place on the 24th at 11.40 p.m.

THE PLANETS.—Mercury (June 1, R.A. $5^h\ 14^m$; Dec. N. 24° 38′; June 30, R.A. $8^h\ 20^m$; Dec. N. 19° 19′) is an evening star in Gemini, and throughout the month is favourably placed for observation. The planet is at greatest Easterly elongation of 25° 28′ on the 27th, when he sets at 9.49 p.m., or 1½ hours after the Sun.

There is an interesting conjunction of the planet with the star ε Geminorum on the 11th, in that the apparent distance between the centre of the planet and the star is only 25″, but unfortunately, conjunction takes place just before noon in this country, though the phenomenon should be observable in India.

Venus (June 1, R.A. $2^h\ 40^m$; Dec. N. 13° 50′; June 30, R.A. $5^h\ 3^m$; Dec. N. 22° 4′) is a morning star in Taurus, rising at 2.30 a.m. on the 15th, or $1^h\ 10^m$ before the Sun. The apparent diameter of the planet is decreasing, being 11″·0 on the 15th, whilst the telescope appearance is gibbous, 0·9 of the disc being illuminated.

Mars (June 1, R.A. $19^h\ 23^m$; Dec. S. 24° 58′; June 30, R.A. $19^h\ 8^m$; Dec. S. 27° 58′) is an evening star in Sagittarius. The planet is becoming more conspicuous as the apparent diameter increases, but the low altitude of the planet is detrimental to good seeing. The planet is due South at an elevation of only 12° above the horizon, on the 19th at 1.30 a.m., the apparent diameter of the disc on this date being 21″.

The planet is in opposition to the Sun early next month, and with diminished distance from the earth the surface markings are becoming more conspicuous; the South polar cap is presented to our vision.

Jupiter (June 15, R.A. $7^h\ 9^m$; Dec. N. 22° 43′) is practically out of range of observation, except during the first week of the month, when he may be seen low down in the North-West portion of the evening sky.

The satellites are practically unobservable in consequence of the planet being in a bright part of the sky.

Saturn (June 1, R.A. $23^h\ 49^m$; Dec. S. 3° 22′; June 30, R.A. $23^h\ 54^m$; Dec. S. 3° 2′) rises about midnight on the 24th, and is in quadrature to the Sun on the 19th. The planet is situated in Pisces and, as shown in last month's issue, the ring appears closed, the telescope appearance being a straight line across the disc.

Uranus (June 15, R.A. $18^h\ 50^m$; Dec. S. 23° 19′) is situated in Sagittarius not far from the position of Mars. The planet rises about 9.30 p.m. near the middle of the month, and is on the meridian about 1 a.m. He can just be descerned with the naked eye about 2° South of the star $\xi^2$ Sagittarii.

Neptune (June 15, R.A. $6^h\ 50^m$; Dec. N. 22° 7′) is out of range being lost in the Sun's rays, as early next month he is in conjunction with the Sun.

METEOR SHOWERS:—

| Date. | Radiant. R.A. | Radiant. Dec. | Name. | Characteristics. |
|---|---|---|---|---|
| | h. m. | | | |
| June—July.. | 16 48 | −21° | α Scorpiids | Fireballs. |
| June 13 .. | 20 40 | +61° | α Cepheids | Streaks, swift. |

TELESCOPIC OBJECTS:—

DOUBLE STARS, &c.—β Scorpii, XVI.$^h$ 0$^m$, S. 19° 33′ mags. 2·7, 5·2; separation 13″·1.

ε Lyræ, XVIII.$^h$ 41$^m$, N. 39° 33′, known as the "double-double" star, can just be separated by the naked eye, but with a pair of opera glasses it is readily divided into two components $\epsilon_1$ and $\epsilon_2$, mags. 4·4 and 4·8. Using a 3-in. telescope and a power of about 120, each of these stars can again be divided into pairs, 3″·2 and 2″·6 apart respectively, each component being about magnitude 5·5.

M 57 (Lyra), the "ring" nebula. This nebula is the only annular nebula accessible to telescopes of about 3-in. aperture, and even then requires good seeing. It is easily found, being situated about ⅛ of the distance from β to γ Lyræ. The usual appearance in a 3-in. telescope is that of a rather large nebulous star, but it bears magnification well, and its annular character can easily be made out with a moderately high power.

M 80 (Scorpio). A compact globular cluster half way between α and β Scorpii; looks like a nebula in small telescopes.